EER BUSINESS AND TECHNICAL JOURNAL OF THE WELDING INDUSTRY

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The Welding Engineer

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November, 1936

Number 11

ELDED construction makes a 60% saving weight over cast-steel truction in this huge attachment.

(See Page 43)

MEMBER AUDIT BUREAU OF CIRCULATIONS

THE WELDING ENGINEER

Vol. 21, No. 11 NOVEMBER, 1936

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EDITORIAL

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Prospects for the Diesel-Driven Welder

● It was not many years ago that the diesel engine—then a big, clumsy, slow-acting machine compared with the Otto-cycle, or gasoline, engine—was considered good enough to operate light and power plants of small or medium size, and to turn the wheels in a few industrial plants where the load was fairly constant.

Today many thousands of them are propelling tractors over farmland, in logging operations, in road-building, and countless other places.

Yet it remained for a few installations in streamlined trains to popularize the diesel engine, and make it a household word.

In some cases, the diesel has replaced the gasoline engine on trucks, in buses, in airplanes, and in many other fields. But it has never made any inroads as a welder-drive unit, though a few diesel-welded installations have been made for railroads, in which the power unit drives a tractor and operates a shovel, a tamper, a welder, or any one of several other pieces of equipment.

The slow speed of the diesel made it impossible as a direct-connected unit to a welding generator. In the last two years, however, the high-speed diesel has come into being, and several manufacturers are supplying these units. Such engines can be governed to operate at about 1,400 r.p.m. and consume only a half a pound of fuel per brake horsepower-hour, representing a fuel cost of between fifteen and sixteen cents per hour while delivering thirty-five horsepower continuously. The total cost per hour for fuel and lubricating oil is about nineteen cents, representing a saving of thirty-five to forty cents over an equivalent gasoline engine.

If a diesel-operated welder in the field is working at or near capacity half of the time, the saving in fuel and lubricating oil would be about twenty-five cents per hour, or two dollars in an eight-hour day.

To make the diesel economical, the saving in fuel must more than balance the additional charges due to the higher price. The higher initial cost of the diesel compared with the gasoline engine has prevented it from encroaching on the gasoline-engine domain in many applications, one of which is welding.

Manufacturers of diesel engines anticipate that increased economies due to reduction in manufacturing operations and greater demand, thereby lowering the cost per unit of product, will before long reach the point where many other applications of motive power will accept the diesel in place of the gasoline engine. Manufacturers have lowered their prices as these economies have been realized.

According to one manufacturer, an engine like that described would be economical if operated a total of 400 hours per year as a welder power unit. Another says that 2,000 hours per year would be necessary to pay back increased interest and amortization charges. It is likely that the former figure is nearer the facts, and, if so, the diesel-drive welder is almost on the scene, particularly where it can be used in fairly continuous service over a considerable period of time.

His time is your time—

save it with dual-advantage "SUPERO-SIAMEEZ" HOSE!

NOW you can prevent the loss of time that welders often spend untangling kinky hose lines in the course of each day's work. "Supero-SIAMEEZ" Hose provides *two* hose lines that handle like *one* . . . a compact twin-hose that goes wherever the workman wants it, without tangling or fouling.

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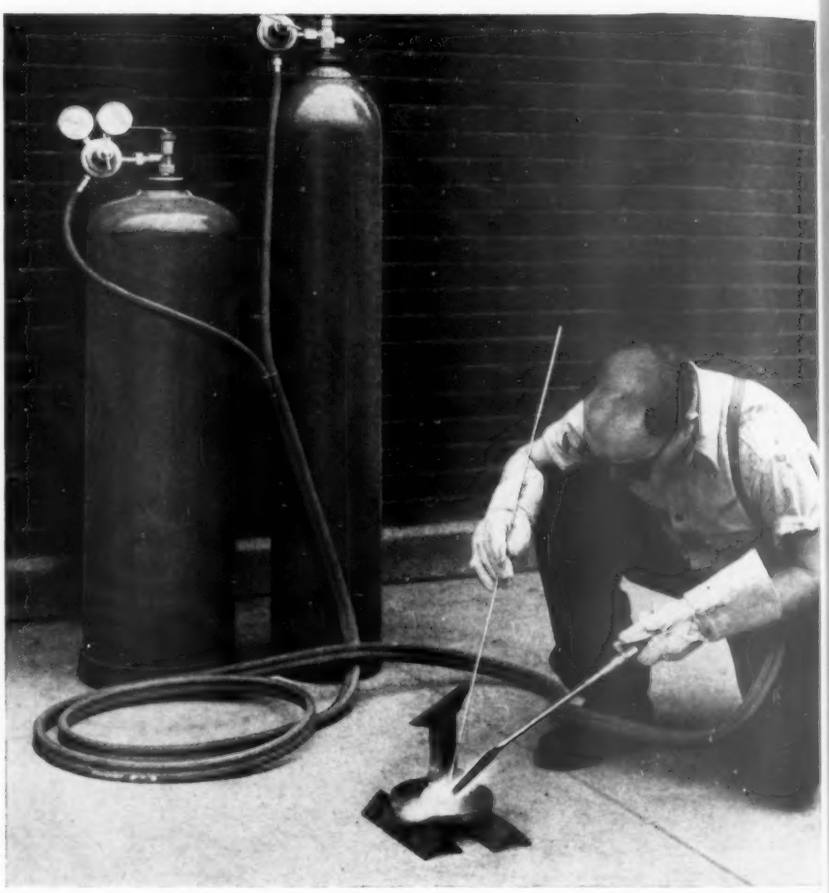
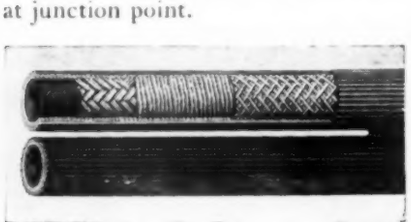


Advantage No. 1 is the unique SIAMEEZ web method of joining the two lines. This web is important! It removes any possible danger of accidental mixture of air and gas . . . it prevents accidental separation of the lines . . . it strengthens the hose walls at junction point.



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The Welding Engineer

VOLUME XXI NOVEMBER, 1936 NUMBER 11

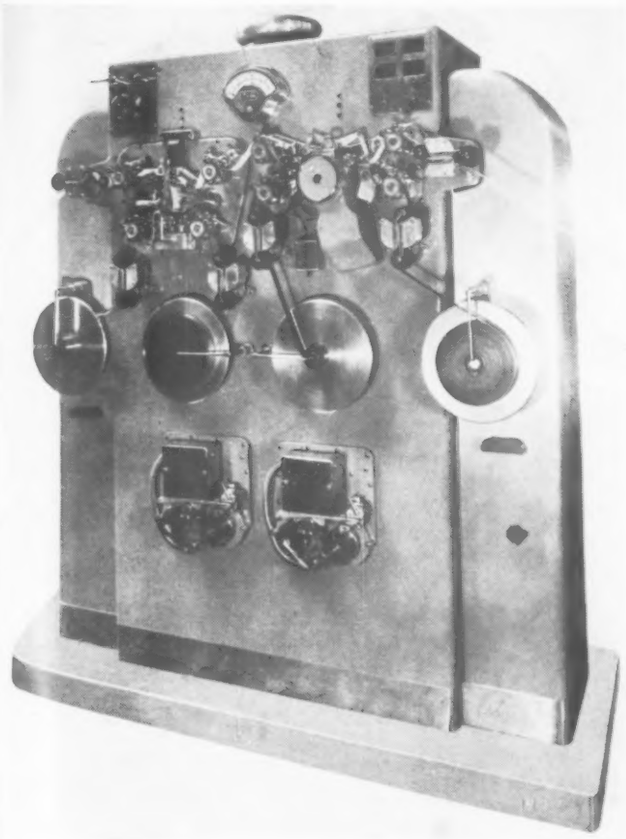
"Metal Carpentry" *Facilitates Building of* Intricate Machinery

By G. H. KOVEN
President, L. O. Koven & Brother

SOMEONE has invented the term "metal carpentry" as a substitute for the much overworked "built-up-welded-construction." It is certainly applicable to the more commonly accepted types of jobs in this field. Press and engine frames, motor and compressor bases, other heavy machine parts and similar construction compare with such rugged wood carpentry work as mine timbering, trestles and shipbuilding, while the lighter type of built-up-welded work corresponds to wood working of a more delicate character.

Metal carpentry has certainly covered a surprisingly wide range of adaptability in the past five years. It has cut weight on finished machinery. It has improved strength by a better distribution of metal mass than is possible in cast construction. It has also made possible for the first time, the use of any required number of metals of definite characteristics to meet specific requirements of service in one strong, homogeneous unit.

In general, the appearance of machines designed for the application of this method of construction is far more attractive than that offered by the rugged but unwieldy-looking cast construction. On the economic side of the picture, the elimination of patterns—particularly on machines which tend to change frequently in design—has reduced the cost of production materially. Of course, it has been possible to do things with "metal carpentry" that are impossible in foundry practice.



This Film Printer Was "Metal Carpentered" by Welding and Cutting.

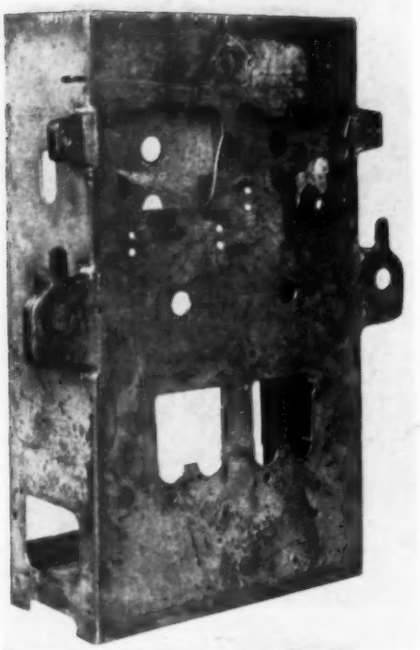
(Frequent changes in design made the use of castings expensive and troublesome. But by adopting welding, the job became as simple as carpenter work.)

Intricate Designs Easily Fabricated by Welding

These outstanding advantages of built-up-welded construction have not been widely used, however, in a field which deserves attention. It is one in which ingenuity in design is of great importance. Without attempting to define the limits of this field of use too closely, let us say that it covers that large group of machines and parts in which the coordination and, frequently, synchronization of many parts into a complex whole is the main problem. Welding can do a great deal more in this field than it has done thus far.

Perhaps the point is best illustrated by describing a recently designed and completed machine on which "metal carpentry" was used. Success in the construction of this machine should indicate a wide field of application for this new art, which presents many possibilities to the technical world and thoroughly justifies the use of the word "art" in that it depends so much on the creative imagination of the designer who adapts it to his needs.

Consolidated Film Industries, Inc., a leading producer of equipment for



Framework of Finished Machine.
(The holes in the plates were quickly and easily made with the cutting torch.)

moving-picture-film processing faced a difficult problem in the production of a machine for printing positive films from negatives. The sound track negative is separate from that of the picture proper, and the machine which prints the positive film from these two negatives is most delicate in design.

It must not only handle at high speed thousands of feet of easily tangled celluloid, control light and time of exposure, but must synchronize with the utmost exactitude the simultaneous registration on the positive film of the sound track and picture record, fed from separate reels.

Up to a few months ago, these machines, as built by this company were of cast construction. They were heavy and unwieldy. They were designed with most of the working parts exposed, since a covering would only add to already excessive weight.

Surfaces were not smooth, except where machining was essential for installation of bearings and shafts. The machine was certainly far from attractive in appearance—a factor not at all to be overlooked in an industry which goes the limit in showmanship, so that even film laboratories are fitted up with the appurtenances and atmosphere of a medical or bacteriological laboratory.

Frequent Changes in Cast Design Made New Patterns Necessary

It happens that the operations carried out by this type of machine lead to quite frequent changes in the design of the machine itself. Thus, when cast construction was depended on, each change in the set-up of the machine not only made it difficult to adapt castings on hand to the new requirements, but also forced the making of complete new detailed drawings for the changed design so fresh patterns could be made. This delayed production considerably and added a great deal to the cost of each machine.

As will be seen from the following description of the machine itself, cast construction involved a great deal of delicate machining. This also added to production costs. But the question of finding a foundry to do this work was in itself difficult. Those large enough to handle the frame on their machines were not used to machine work as delicate as that required. Smaller foundries, on the other hand, could not handle the frame.

The engineering department of the company became interested in the possibilities of "metal carpentry" for this machine. As the illustration showing the frame before fitting indicates, there were a great many accurately placed openings to be provided for. The smooth surface of the heavy metal plate which built-up-welded construction offered, was a definite advantage for the fitting of the machine, if a frame of the required strength and rigidity could be devised.

The proposition was put in the hands of L. O. Koven & Bro., Inc., whose work in welding had already been approved by the company. After detailed study of the problem, the design which resulted in the finished machine illustrated here was approved.

Welded Fabrication Presents No Serious Problems

The photograph shows the framework for the finished machine as produced by welded construction. It is obvious that no great welding difficulties have been encountered. The frame is in effect a form of tank, into which, by suitable burn-outs and welds, a plate of the required shape and stiffness for main reel bearings was put. The welding problems involved are not severe; the interest of the job is primarily in the adaptation of metal carpentry to a machine of this character.

The holes that were burned out, many of them being of unusual shape, provided for the insertion of special parts on the finished product.

In addition to this framework, two wing covers of aluminum were fabricated, these being used to cover the complicated relay system on the finished machine, one set on each side of the frame.

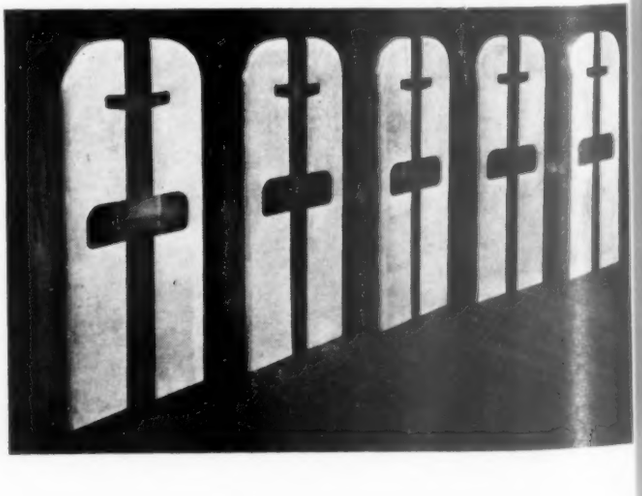
It was found that the actual fitting of the machine with the welded framework was far more rapid and satisfactory than it had been with cast construction. All surfaces where bearings, shafts and other parts had to be installed were smooth. Hence any slight changes in the location of a part did not result in the complications that would have arisen with cast construction requiring new machining operations.

Welded Construction an Aid to Accurate Set-Up

Accuracy of set-up during fitting was easily obtained with the rigid welded frame, having exactly located openings. In fact, the welded frame produced a finished unit capable of much finer adjustment and far more rapid production, in spite of the unit exacting demands in synchronization and timing.

The finished machine had an exceedingly pleasing appearance with light gray body, chrome-plated handles and bright aluminum wing covers. This original machine, which has been in service for some months, is being followed by five more similar units now under production in the same plant.

What should be of major interest are the things accomplished by this design, beyond actual technical performance of the machine itself. First, since these machines are made in the East and shipped to Hollywood, the great reduction in weight is a most desirable feature. The workmanlike appearance—a great improvement over the ungainly cast machine which preceded it—was enhanced by the fact that the new design is a completely enclosed machine, looking like a finished production unit, whereas the cast design had a good portion of its



Aluminum "Wings" for Finished Machine.
(These cover the complicated relay system on the sides of the welded printer, and form a part of the general assembly.)

reels and bearings extending from the outer surface.

Much is saved in the design of this machine, since the drawings required for the production of the cast frame had to be far more complete than those for welding. Patterns, of course, have been completely eliminated. No machining is required on the welded unit, since the plate surfaces of the finished frame are amply smooth for all fitting. Incidentally, this smooth plate surface made possible the painting of the finished unit, whereas the rough surfaces of the cast machine made an attractive paint job impossible. The elimination of machining cut another large amount off the cost.

Actually, as has been indicated, slight changes in fitting requirements were readily met in the welded design, whereas in the cast design such changes were either expensive or impossible.

Another important point is cleanliness, which is vital in film work. Any machine that cannot be kept immaculately clean is liable to ruin valuable films, since even the most minute speck of dust can lead to imperfections. The cast machine, with its rough surface and exposed parts, was an invitation to the collection of dust, and was very hard to clean.

The welded unit, with its smooth surfaces and complete enclosure, keeps dust out and prevents it from collecting, and also is easy to keep spotlessly clean at all times. Note that the cover extends all the way to the floor.

No doubt far more intricate metal carpentry jobs can be applied to this field of complex machines. The fact that the welding portion of this particular job is comparatively simple does not invalidate the point brought out at the beginning of the article—that even in machinery where the greatest delicacy of adjustment in operation is essential, metal carpentry can be used for its usual advantages of lowered production and overhead costs, greater strength, improved appearance, reduced weight, and better adaptation of metals or alloys to specific requirements.

Three Firms Contract for Welded Buildings

The Republic Steel Corp. is erecting a welded building to house their new wire mill at their South Chicago plant, the structural contract having been awarded The Austin Co., Cleveland, O. All-welded construction will also be employed in the fabrication and erection of a modern research laboratory for The American Rolling Mill Co. at Middletown, O., and for an addition to the plant of the Electro-Motive Corp., at McCook, Ill. (a suburb of Chicago), both of which contracts also have been awarded The Austin Co.

The Republic mill, which is now well under way, involves 1,400 tons of steel. It is built on a marsh, over which was laid a 9-ft. fill consisting of 100,000 cu. yd. of slag from Republic's slag dump, a quarter of a mile distant from the site. Over this is poured 164,000 sq. ft. of concrete floors required in the five sections of the mill.

The American Rolling Mill laboratory at Middletown will be a single-story building employing porcelain-enameled sheets, other decorative metal products and glass blocks, and will cost approximately $260,000, exclusive of equipment. A multiple-story building of equal floor space but of conventional construction would cost about $400,000, it is claimed. The structure replaces the company's research building which was leveled by an explosion in December. Provision is made for later enlarging the building by an addition to the rear half as large as the initial structure.

In employing welded construction in the new Electro-Motive Corp. extension, the company is following the same type of construction as used in the existing buildings. This extension will double the length of the main erecting and machine-shop aisles to provide an area approximately 1,100 ft. long and 104 ft. wide, entirely without obstruction, to be serviced by the great 200-ton welded traveling crane.

A. W. S. Fall Meeting Creates High Interest

What was generally considered by those in attendance to be an unusually brilliant series of papers, marked the technical sessions of the fall meeting of the American Welding Society, held in Cleveland during the week beginning Oct. 19. The details of the program were announced in the October issue of *The Welding Engineer*. Discussions of some of the papers were quite lively, and marked interest was shown.

At the business session on the opening day, the following officers were announced as having been elected for the coming year: President, Alfred E. Gibson, The Wellman Engineering Co., Cleveland, O.; senior vice-president, E. R. Fish, The Hartford Steam Boiler Inspection & Insurance Co., Hartford, Conn.; divisional vice-presidents (term two years): New York and New England, John H. Zimmerman, The Linde Air Products Co., Newark, N. J.; Middle Eastern, R. D. Thomas, of R. D. Thomas & Co., Philadelphia, Pa.; Middle Western, H. C. Boardman, Chicago Bridge & Iron Works, Chicago, Ill.; and directors at large: Ira T. Hook, The American Brass Co., Waterbury, Conn.; G. A. Hughes, Truscon Steel Co., Youngstown, O.; R. E. Kinkead, consulting engineer, Cleveland, O.; H. S. Smith, Union Carbide Co., New York, N. Y.; and Andrew Vogel, General Electric Co., Schenectady, N. Y.

The Samuel Wylie Miller Memorial Medal was awarded to H. M. Hobart, of the General Electric Co., Schenectady, N. Y., as announced elsewhere in this issue.

The annual banquet, dance and entertainment on the evening of Oct. 22 was well attended. On the following day two bus loads of visitors were taken to the plants of The Wellman Engineering Co. and the Cleveland Crane and Engineering Co. to look over plant equipment and see their fabrication methods. A lunch was served for the group at the Nela Park laboratories of the General Electric Co., where special demonstrations and talks pertaining to light were given.

The exhibit itself, at the Public Auditorium, was described by many who saw it as the most attractive industrial exhibit ever held in this country. It established new records for these shows, both in floor area of the exhibit and in number of exhibitors. Expressions from exhibitors regarding the show seemed to be almost unanimous that it set a new record for the amount of business done and worthwhile contacts made, notwithstanding that the attendance was not as great as in previous shows because of changes made in requirements for admittance. Though the general public was more effectively excluded than at previous shows, the men connected with or directly interested in the metal industries seemed to be well represented among the visitors.

Welded Steel and Concrete Structures in Kansas

Sumner County, Wellington, Kan., have just completed a new warehouse of welded steel and concrete design. A new acetylene-generator house of fireproof construction is equipped with vapor-proof lights and switches. An oxygen manifold is being installed to eliminate the customary frequent interruptions to change bottles. Ground has just been broken for the new shop building to replace the one that was destroyed by fire about a year ago. This building will also be of welded steel and concrete design.

Jones & Laughlin Building Ten Welded Steel Barges

The Jones & Laughlin Steel Corp., of Pittsburgh, have completed the first of ten all-welded steel barges, for their own use, which are to be employed in the transportation of manufactured steel products from Pittsburgh via inland waterways to southern ports. These barges, which have a capacity of 1,000 tons each, are 132 ft. long, 35 ft. wide and 11 ft. deep.

Welding Applied to Reinforced-Concrete Structures . . .

By O. BONDY
Structural Engineer,
London, England

QUITE a number of applications of welding in reinforced concrete structures have been made, especially in the United States, Australia, Belgium, France, Germany and Norway. Each of the three main processes of welding has been used, namely, gas welding, electric-resistance and electric-arc welding, and tests with new types of welded joints for reinforcing rods have been carried out. Buildings and bridges of considerable span have been erected in recent years by this method.

This report deals only with some of the principles of welding design as far as reinforced concrete is concerned, and with details of a number of concrete bridges recently erected in Belgium with arc-welded reinforcing bars. In the field of concrete buildings, last year's World Exhibition at Brussels gave some idea of the possibilities, as one of the main halls consisted of three-hinged arches of 285 ft. span each, with butt-welded reinforcements.

Concrete Section Can Be Smaller If Joint Is Welded

A welded joint in a reinforcing rod has many advantages as compared with the hooked lap, but the type of welded joint must be chosen to suit the requirements of the individual case. The primary advantage is the reduction in the cross-section of the reinforced concrete. No additional section of concrete is required when the rod is butt welded. Moreover, such a welded joint saves weight, compared with the overlapping joint in present use, and the welded joint adds considerably to the rigidity of the whole reinforcement and helps to avoid loss of time caused by distortion due to handling in the field.

Tensile and bend tests have been carried out on a great number of different types of welded joints and the results give a clear indication of their relative merits. Some of the welded joints are shown in Fig. 1, including some types which have been tried only in laboratory tests and which have been abandoned in favor of better types.[1]

The length of lap L_1, in Fig. 1-a is saved with every type of welded joint, and the overlapping lengths L_2 in Figs. 1-b and 1-c are extremely short for welded joints, if based only on the theoretical length of fillet weld necessary to carry the force T. Because of the moment of eccentricity, which can be expressed as $M = T \times d/2$, and for many practical reasons, the length of overlap L_2 for such welded joints must fall between $4d$ and $8d$, where d is the diameter of the reinforcing bar.

Various types of coupling boxes have also been adapted for welding. According to present practice, the ends of the bars are upset for about 8 in. at each end, so as to make use of the full section of the bar, and then a thread is cut at these ends, using a power-driven machine whenever possible.[2]

Sleeve Joints Simplify Field Work

If welding is applied to such joints, the above preparation is not necessary, and the procedure may be simplified, as shown in Figs. 1-d and 1-e. These types of joints are especially useful on vertical bars; the sleeve is slipped over at one end and the circumferential weld W_1 is made in a convenient position. To complete the joint in the field, the upper bar is slipped into the vertical sleeve and the other weld (W_2) may be made downhand without difficulty.

The other type of sleeve joint, shown in Fig. 1-e, has a slotted sleeve with slot welds, which add to the strength of the joint. The necessary thickness of such sleeves, for transmitting the same force as carried in the bar, may easily be calculated as follows:

$$\frac{D^2\pi}{4} - \frac{d^2\pi}{4} = \frac{d^2\pi}{4}$$

Hence, $D^2 = 2d^2$, or $D = d\sqrt{2}$.

By using sleeves of higher tensile

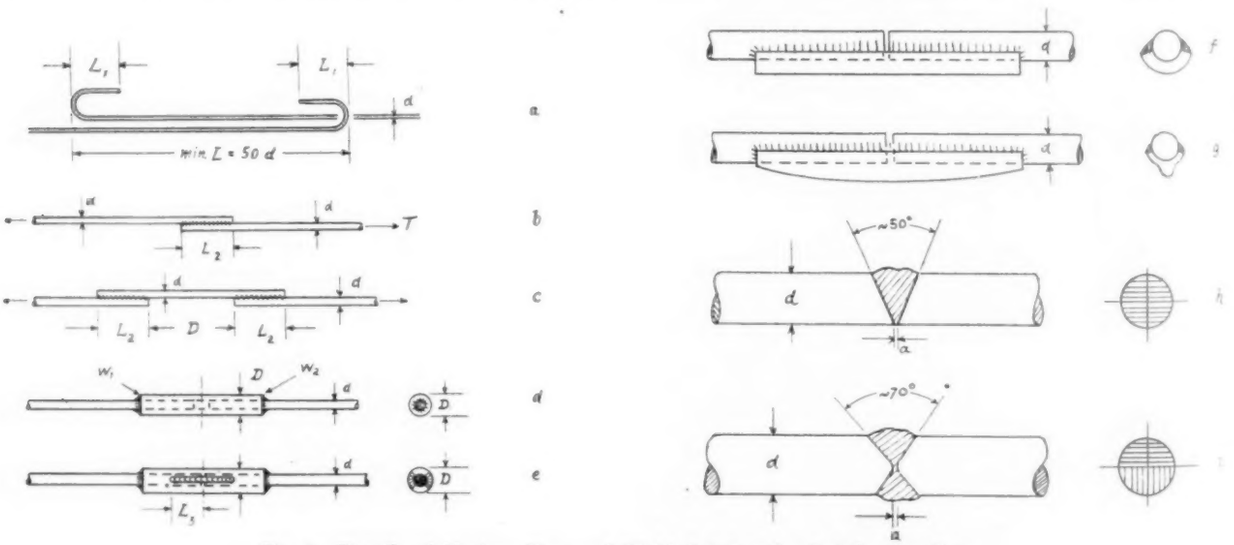


Fig. 1. Details of Various Types of Welded Joints for Reinforcing Bars.

strength, their thickness may be further reduced. The advantages of the welded sleeve joints are that they require no preparation in the field, and that the forces are transmitted through the joint without any eccentricity.

To avoid field welding except in the downhand position, further types of joints have been developed (see Figs. 1-f and 1-g). These are intended for horizontal bars only, and the half sleeves are arranged in such a way that the center lines of the fillet welds coincide with the horizontal center plane of the reinforcing bar. Though the half-sleeve itself is exposed to a bending moment, the improved shape with a back rib on the sleeve has been tested at 36.5 tons (87,600 lb.) per sq. in. breaking strength; that is, the joint shows 100% efficiency when tested with a high-tensile steel of 34-36 tons (82,200-87,000 lb.) per sq. in.[3]

Conventional Joints Are of the Butt-Weld Type

Although these types of welded joints show some advantages when compared with present-day practice, it is the writer's opinion that these technical advantages are not sufficient to justify the expenses which necessarily occur in introducing a new procedure, but that butt-welded joints will prove satisfactory and will come into general use. They may be of the single-V or double-V type, as shown in Figs. 1-h and 1-i. In fact, the ends of the rods may be beveled or not, and any of the three processes may be successfully applied.

Gas welding results in a greater amount of heat being distributed over a greater length of the ends, compared with the other welding processes, but the strength of the joint is certainly 100% of the reinforcing-rod strength.

Electric-resistance welding saves beveling the ends, and is also definitely reliable as regards obtaining 100% joint efficiency, but the installation of a rather expensive resistance-welding machine would be justified only for a large job where a great many welded joints are to be made, especially if the reinforcing rods are of great diameter.

Up to the present, electric-arc welding has been mainly applied, and based on experience in various countries it may be considered the most economical welding process in reinforced-concrete work. A.c. or d.c. welding machines are being built to any requirement, and they can be easily installed on the job if the necessary power is available; otherwise gasoline-driven machines are advantageous, in that they are independent of any resources.

The question of electrodes is no problem any longer. Bare wire is still much favored in some countries, including Germany, while covered electrodes may

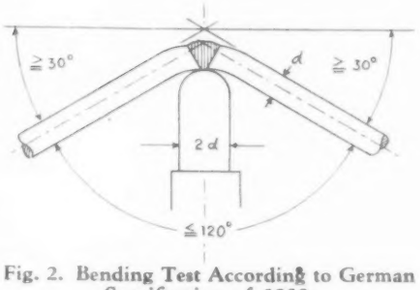


Fig. 2. Bending Test According to German Specification of 1932.

generally be recommended for welding in the field under the difficult conditions which prevail in reinforced-concrete work.

European Countries Draft Regulations

Regulations for welding reinforcing bars were drafted in Belgium in 1934, and several conditions were also included in the German Specification for reinforced concrete of 1932. The latter makes it a condition that reinforcing rods are to be welded in accordance with DIN 4100 (Regulations for Welded Steel Structures). In 1932, only 60% was allowed for the working tensile stress of the welded joint, as compared with the parent metal, but since August, 1934, this figure has been increased to 75% for members in tension.

Based on such permissible stresses, the advantage of the welded joint remains rather problematical. However, welding has been employed for reinforced-concrete structures in Germany since 1930.[3] According to the German regulations, the authorities may ask for bending tests as shown in Fig. 2. The minimum bending angle of 60° must not result in any cracks. This condition is not to be considered as a rigorous one, and butt welds made with covered electrodes will usually reach a far greater bending angle without failure.

Belgian regulations, drafted in 1934 by the Belgian Standards Institute,[4] allow 80% as the permissible stress of a single-V butt weld in tension, as compared with the parent metal. One of the conditions attached is that three butt-welded test specimens are expected to break in the parent metal and that no distortion is to be permitted. 100% stress is permitted for butt welds in compression. Without any restriction, welding may be used for securing rods in position—for example, for binding and fixing. In practice, tack welds are quite sufficient for this purpose.

Though all these regulations may be expected to give considerable help to the reinforced-concrete designer, full advantage of welding will not have been taken until 100% strength of the welded joint has been proved by a series of tests, and has been recognized and allowed for in official regulations.

In the accompanying table, comparison is made of the permissible working stresses for butt welds in various countries. The figures apply to welded joints in steel structures only, with the exception of Germany and Belgium, where the indicated stresses are permitted for welds in reinforced-concrete structures. Great Britain allows for the highest percentage figures in tension and shear in butt-welds—namely, 85%.[5] But in recent months similar high figures have also been set up in new regulations for welded bridges as recently published in the United States and Germany.

Permissible Working Stress in Single-V and Double-V Butt Welds.

		Per Cent of Parent Metal			Long Tons Per Sq. In.		
	Year	Tension	Compr.	Shear	Tension	Compr.	Shear
Great Britain	1934	85	100	85	.....	.....	.....
Australia	1933	.....	.....	.....	7.0	7.0	5.6
Germany	1934	75	85	65	.....	.....	.....
Germany Bridges	1935	80	100	65	.....	.....	.....
Austria	1934	75	90	65	.....	.....	.....
Switzerland	1935	70	100	57	.....	.....	.....
Czechoslovakia	1932	.....	.....	.....	5.1	7.0	4.4
Hungary	1933	.....	.....	.....	5.4	7.3	3.2
Belgium	1934	80	100	.....	.....	.....	.....
U. S. A., Bridges	1936	89	89	67	7.1	7.1	5.3

Testing and Supervision Promote Good Work

At this point, attention must be drawn to the fact that in the field of reinforced concrete not only experienced designers and competent craftsmen are essential but also strict conditions for testing and supervision should be laid down before starting work. In making use of high-tensile steels, special precautions are to be taken, as their welding qualities differ considerably from those of mild steel.[6]

Some of the reinforced-concrete bridges with butt-welded bars are of in-

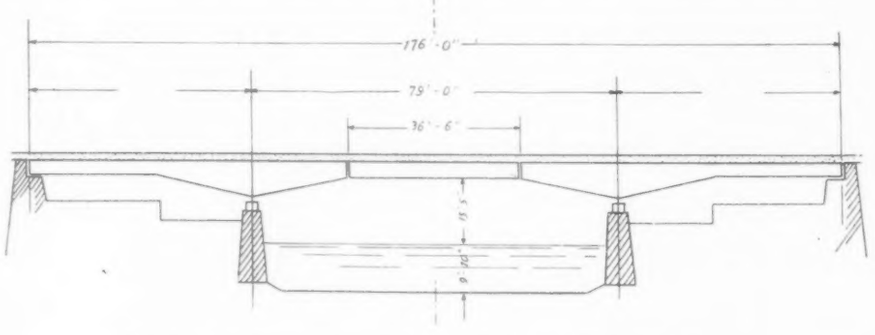


Fig. 3. Main Dimensions of One of the Three Brussels Bridges.

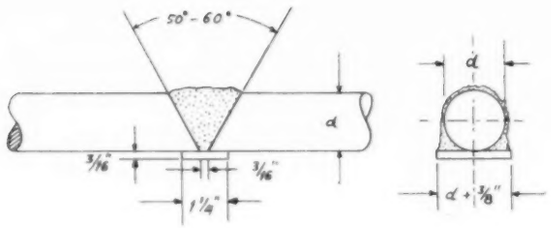


Fig. 4. Type of V-Butt Weld Used on the Brussels Bridges.

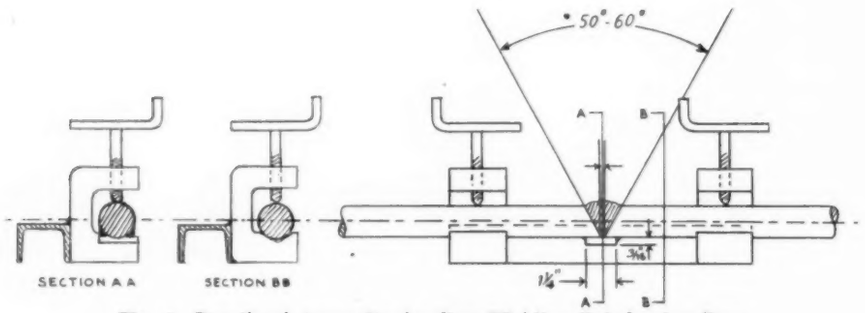


Fig. 5. Details of Arcos Jig for Butt Welding Reinforcing Bars.

terest in this connection. The highway bridge at Termonde, Belgium, contains a great number of butt-welded reinforcing bars, as follows:

Bars of 1¼-in. diameter, 84 joints.
Bars of 1½-in. diameter, 24 joints.
Bars of 1⅞-in. diameter, 484 joints.

Bottom Plate Helps to Obtain Penetration at Root of Weld

This bridge, of 200-ft. span, proved so successful that another series of three concrete bridges over the Charleroi-Brussels Canal were erected in a similar manner. The main dimensions of this cantilever bridge are shown in Fig. 3. The standard type of butt welds as applied to these Belgian bridges is shown in Fig. 4. To be sure of sound penetration at the root of the weld, a small bottom plate, about 3/16 in. thick, was tack welded to both ends of the rods, thus replacing the sealing bead, which is of such importance for obtaining the full strength of a single-V butt weld.

Special jigs have been developed for holding down the ends of the rods in their correct position.[1] At first, the ends of the rods are restrained and clamped as shown in Fig. 5. Then they are beveled to V-shape by means of the oxygen-flame, or even by the electric arc. A small bottom plate is then tack welded to the ends of the rods, after which the welding is done, beginning with sound penetration at the root and building up layer on layer. Such a jig may be made right on the job, and preparation of the ends of the rods is a comparatively easy task. Of course, it makes for efficiency and economy if a goodly number of such jigs are available so that positioning of the rods can be done by one gang and the welding itself by another.

Fig. 6 shows positioning of the rods by means of a jig of the type described above, with a single-V joint made on the spot, a tin being placed below the joint to safeguard the timber parts against sparks and hot slag during flame cutting. To avoid inconvenience to other operators from arc glare, the welders usually work within a small tent or behind a screen.

Computing Amount of Metal Deposited and Welding Cost

The cost of a welded joint for a reinforcing bar comprises the cost for assembling, cutting the ends and welding; the last named including the cost of electrodes, electric power and labor. Knowing the values of these three factors, one can compute the welding cost from the amount of metal to be deposited. Referring to Fig. 7, for V-butt welds,

$$\text{weld volume} = \frac{d^2\pi}{4}(l + a).$$

But

$$l = d \times \tan 30° = 0.58\ d.$$

Therefore,

$$\text{weld volume} = \frac{d^2\pi}{4}(0.58\ d + a).$$

For practical purposes, an additional 25% of electrode volume is allowed for the reinforcing area and another 25% for loss by spattering, etc.

To weld a V-joint on a reinforcing bar of 1¼-in. diameter, 6 to 7 electrodes have been used, each 5 mm. (about 3/16 in.) thick and 18 in. long. It took about 30 minutes to make each joint, including positioning in the jig and dismantling afterwards.

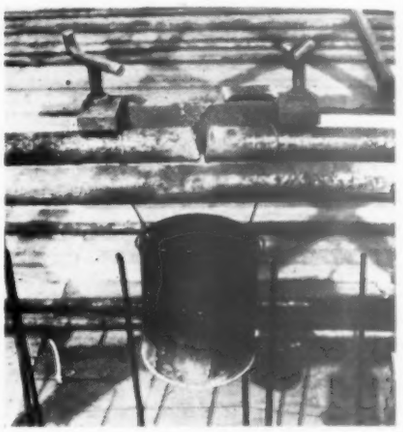


Fig. 6. Positioning the Rods by Means of the Jig.

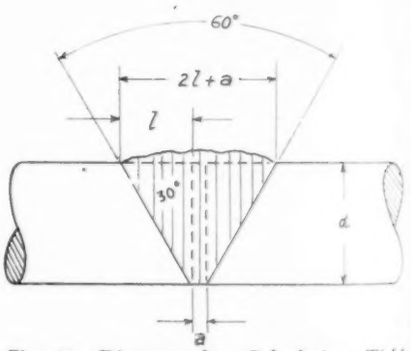
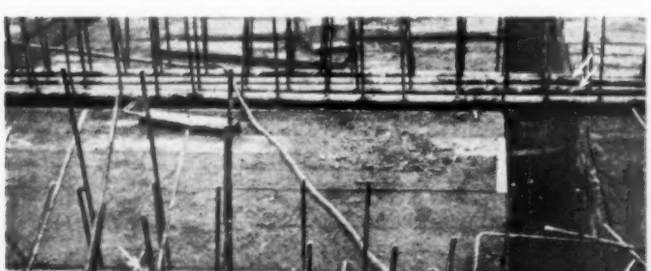
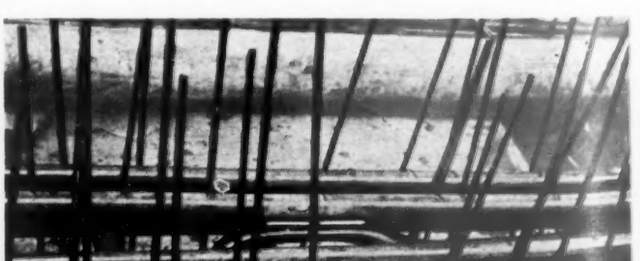


Fig. 7. Diagram for Calculating Weld Volume.



Photograph by Arcos, Brussels

Fig. 8. Butt-Welded Reinforcements in Position.



Photograph by Arcos, Brussels

Fig. 9. Reinforcements With 8-In. Side Fillet Welds.

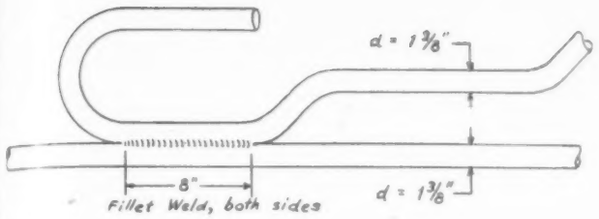


Fig. 10. Overlapped Welded Joint Used in Termonde Bridge, Brussels.

Each of the Brussels bridges consisted of 13 main girders, as shown in Fig. 3, and a great number of field welds had to be made. Fig. 8 indicates the position of some of the butt-welded rods, of about 1½-in. diameter.

Also, another type of welded joint had to be made, which is shown in Fig. 9. Approximately 1,500 welds of this type were made, compared with approximately 1,000 butt welds in 1½-in. diameter rods. Fig. 10 shows the arrangement of these joints with side fillet welds about 8 in. long.

Welded Reinforcement in Arches at Brussels Exposition

Not only to bridges, but also to reinforced-concrete buildings, welding has recently been applied with notable success, one of the outstanding achievements being the three-hinged arches for the World Exhibition at Brussels in 1935, having a span of about 285 ft. each and butt-welded reinforcing bars.

In conclusion it may be said that welding has already found many applications in the field of reinforced concrete for both bridges and buildings. Of the many types of welded joints, only V-butt welds appear so far to have proved their efficiency. Further development will largely depend on whether the welds themselves will be considered to be as good as the parent material. Considerable progress has been made in this direction in a comparatively short time, and perhaps the "100% butt weld" will be introduced into reinforced concrete on a larger scale before long.

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Machinery Goes Modern by Adopting Welding

By H. S. CARD
Development Director, Electric Welding Section, National Electrical Manufacturers Assn.

If the present trend of business activity continues, it will not be long until the machine-tool industry finds itself face to face with an unprecedented demand for new equipment. How this demand can be met to the best advantage, whether by adhering to old established practices of design and fabrication, or by boldly adopting new designs and new manufacturing methods, is a question that each machine-tool manufacturer must answer for himself.

The important fact is that during the past ten years some builders have "gone modern" to the extent of replacing cast parts in their structures with arc-welded rolled-steel assemblies. Furthermore, the degree of success attending this conversion has been too high to admit of dismissing modern welded-steel construction as a passing fad. In a competitive market the salesman who is backed by production efficiency has a distinct advantage. His competitor cannot laugh off the story of "a better product at a lower cost." Therefore, a complete picture of the advantages of arc-welded steel construction is of immediate and vital interest to the machine designer.

But let's not attempt to tear down what industrial engineers have so laboriously built up over a long period of years. A lot of fine brain work has been contributed to make up our present knowledge of machine design and foundry practice. To toss such an asset out of the factory window is not to be considered. The foundry executive who visualizes welded construction as something invented to put him out of business, simply doesn't see the picture clearly. There is nothing to prevent him from using the process to modernize and to increase his present business.

This brings up the question: "Is it worth doing? Are the advantages of rolled-steel construction real, and are they diversified?" In reply, there is an abundance of convincing testimony and experience. The writer has just made a searching study of current literature on the subject, and has found existing examples to verify the following advantages claimed for welded steel construction when properly used:

(1) General speeding up of production schedules.

(2) Reduction of unit construction cost.

(3) Elimination of pattern costs.

(4) Elimination of costly pattern storage facilities.

(5) Elimination of casting reject losses.

(6) Reduction in machining costs; particularly when castings are found to be defective subsequent to machining.

(7) Rolled steel is stronger, stiffer, more resistant to fatigue, shock and impact; more uniform, lower in cost per pound.

(8) Flame cutting permits the easy fabrication of irregular parts from standard shapes.

(9) Design can be simplified.

(10) Design can be changed even after a job has been started.

(11) Assembly can be simplified.

(12) Ease of fabrication of parts by flame cutting reduces the necessity for carrying stocks of obsolete parts.

(13) General reduction of inventory.

(14) Reduction in weight, where weight is not needed, up to 30% without sacrifice of strength.

(15) Lower shipping cost.

(16) Lower power cost.

(17) Lower installation cost.

(18) Greater freedom of design through removal of restrictions imposed by foundry practice.

(19) Trimness and neatness of modernistic designs are readily obtainable.

(20) Rush jobs can frequently be completed in the time required for making a casting pattern.

(21) Simplified castings can be used in assembly with rolled shapes.

(22) One solid structure may be assembled from several different steels, each steel being used where it will function best.

(23) A wide variety of treatment for wearing surfaces is available.

(24) Stress concentrations can be controlled with minimum added weight.

(25) Maintenance costs of the steel structure will be lower.

(26) The results of good welding procedure are predictable within very close limits.

(27) Wherever weight on bearings is reduced, faster operation and power savings are natural sequences.

(28) The most complex designs, which make casting difficult, offer no special problem to the welding department.

These are advantages of a sort to interest any hard-headed business man in good times and bad. They account for a tidy volume of business now enjoyed by a few established welderies that are equipped to serve the machine-tool field.

These advantages have been proved over and over in practice, and in nearly all cases where machinery has been designed for welding a large number of the advantages have been secured on a single job. The alert machine-tool designer will take these statements as a challenge to his own progressiveness, and will investigate them. And, finding them correct, the rational thing for him to do is:

(1) To find out in each case how many of these advantages he can secure —at a profit, and

(2) To combine the new process with the old and give the new the benefit of the same study he has given the old.

Safe Practices to be observed In Welding...

An address delivered at the 25th National Safety Congress & Exposition, Atlantic City, N. J., October 5-9.

By C. V. DAVISON
Superintendent of Pipe Manufacturing, American Rolling Mill Co.

IF OUR welders are not instructed properly in how to do their jobs we may cause accidents to individuals who have put their confidence in our ability. Each day thousands stake their lives on welding, a great many of whom do not know what welding is.

Check the welding jobs under your jurisdiction and visualize what might happen to the users if your welders do not do a sound job. A weld that looks perfect on the surface may underneath have lack of fusion, slag inclusions, or burnt material which would cause breakage unless there is a great margin of safety in the design.

Welders Must Be Made "Sales Minded" For Best Results

One solution to this problem is for the welding supervisor to get his welders sales-minded. The welder depends on the salesman for his work; the salesman depends on the welder's quality to get this work. He must have a job to sell that he knows will prove satisfactory.

We try to educate our welders to know that a salesman has only five tools: quality, cost, service, a knowledge of his job, and good will. The welder can control the first three; these, combined with the fourth, make the fifth.

The approach to an ideal safety set up —safety *in* welding and safety *from* welding—may look complicated, but I shall outline how we approached our problem.

Late in 1934 our business increased to the point where it was necessary for us to take on additional welders, which we could not find in our territory. Thus we were forced to make welders, as welding, like many industries, had not trained many apprentices during the depression. We selected as a training instructor one of our best welders, who had a thorough knowledge of our products and procedures, and developed a course of training not only to help our older welders, but to develop new ones.

Welders Are Unacquainted With Safety Practices

Each job was broken down into its component parts—safety in the plant and safety of our product in the field. We selected as an experimental group 35 men, a few of whom had had welding experience. These men had varied types of education from three years in grade school to some college training. We were very much surprised to learn how little some of the men whom we considered good welders knew about their equipment and how to use it safely.

One of the first things we studied was the safety switch which controls the current going to the welding generator. How many of your welders know that this switch should be disconnected when making repairs to equipment? Also that this switch should be pulled out with the left hand while standing at one side, so that if there is a flash when the circuit is broken, the workman will not be burned about the face, since the majority of these switches are set from 4 to 5 ft. off the floor? This may seem like a minor detail, but through one man's knowledge of this point we avoided quite a serious accident when a switch was being pulled on a 440-volt line and the flame shot out several feet. Our workmen were also instructed always to open the safety switch before opening the cover of the starter for any reason.

They were shown why they should never place metallic objects near the welding set. Under "Reactance" we have a paragraph which reads: "Never place metallic objects where they can contact the coil of the reactor while the unit is running. This may result in damage to the equipment or a severe burn to the workman."

We do some welding with resistance banks. The operator is instructed as to how these resistance banks function; he is also told before any attempt is made to repair a resistance bank to be sure that the safety switch feeding the bank is open. Otherwise he might be burned.

Welding leads are one part of our equipment which get terrible abuse, as they are often dragged across sharp corners of steel plates, concrete, or brick floors; such treatment tends to cut off the insulation. Often a welder, not understanding his job thoroughly, will select a lead too small to carry the necessary current, which may burn off the insulation.

The electrode holder is another greatly abused tool which, when not properly taken care of, will cause excessive heating and may burn a worker. If the holder is thrown down carelessly, it may cause a flash which is likely to burn bystanders.

Care should be taken in placing leads around the floor, as someone might trip, injuring himself as well as breaking a connection which might cause a flash.

We have had some flashes from welding hoods, due to their shape, misuse and leaks around the lenses. Our training has largely eliminated this condition; we have shown the operators what rough usage will do, and the trained man will not work with a hood that has holes permitting light rays to enter.

We supply each welder with a slag hammer and brush to clean his weld and have tried to have each welder wear a light pair of goggles under his hood to cut out light rays and also to prevent flying objects from entering his eyes while chipping slag. This has been quite a problem, as it has been very hard to find a safety lens goggle light enough for this purpose.

We instruct our welders and their helpers in the proper methods of handling the materials with which they work —principally pipe, quite often of irregular shape.

We try to get the welders to put the ends of their electrodes in boxes; on the floor they present a falling hazard.

Fresh Air Needed When Working in Confined Spaces

The gases given off from an electrode are not dangerous in the open, but when welding in a confined space, the worker should be instructed to make provision for fresh air. With all the work we have done along this line, we still find our welders working in confined spaces without proper air. This point should be stressed, as a welder might become gassed when working alone and not be able to get relief until it is too late.

An arc screen is not used enough in a great many plants. The welder, if properly clothed, is safe from flashes and burns, but without screens he often subjects other workers to hazards. The best type of screen is a light, portable one made from pipe and fittings to which is attached a piece of awning. It should, if possible, entirely surround the job.

It is often necessary for a welder to do his own cutting, and sometimes this is done by men unfamiliar with the proper handling of cutting gases and cutting equipment. Sometimes the workers around a plant will foolishly turn on the valves and play with the adjusting screws on the regulators. Each man, before he starts to cut, should check the valves and regulators to see that they have not been tampered with. Oil or grease should not be placed on an oxygen connection, because these materials will not mix with oxygen except as an explosive.

Regulator Threads on Gas Tanks Should Be Protected

Regulators on gas and oxygen containers are connected to the valve by threaded connections. Such connections should be protected from bumps or cross threading or they will become useless. Bottles, whether full or empty, should be stored in their proper places.

Oxygen bottles are charged with very high pressure and should be given special safety attention. Should a valve be broken, the pressure would exhaust with such force that the heavy bottle would turn into a rocket. The safety cap should never be taken from the valve until the bottle is placed in position for use and made secure.

Oil under pressure is highly explosive and should never be placed on threads or connection of oxygen bottles.

When not to be used for some time, the valves on both oxygen and acetylene bottles should be turned off securely to avoid waste and fire hazard.

Too much pressure should not be exerted upon the hand screw of the regulator, or the mechanism inside may be injured. The hand screw should always be run out when the valve on the tank is closed, to protect the low-pressure gauge when the valve is reopened.

Acetylene connections are always made with left-hand threads, while oxygen connections are made with right-hand threads. This is done to reduce hazards. Connections should be checked carefully before they are made.

Defective gauges or regulators should not be used but should be reported to the foreman or service man in order that repairs may be made. Defective equipment often results in defective workmanship and in many cases makes the job dangerous.

Hose should be protected from hot sparks and metal. It should never be run over, and excessive tension should not be placed on it. Oxygen and acetylene hose should have right- and left-hand connections, respectively. Excessive pressures, which might burst the hose, should be avoided.

Torches are made to be used only as torches and should never be used as hammers or pry bars; such treatment would result in distortion or breakage, making the unit useless. Leaks in connections, valves, tips or torches are dangerous and should be reported to the foreman or maintenance man. It is essential that tips be kept clean and in good condition always.

Goggles are purely a safety device. They should have non-shattering lenses of special amber-colored optical glass and should always be worn over the eyes while cutting, for protection against glare and flying particles of metal or slag. The outer clear glass should be changed for new when it becomes spattered to the extent that vision is obstructed.

Friction lighters provide a much safer method of lighting a torch than matches.

Good, tight-fitting wrenches should be used when changing any connections on cutting equipment. The brass nuts would easily be chewed up or the corners rounded off by the use of poor wrenches, pliers or pipe wrenches.

Welding Manganese Liners to Cast-Iron Journal Boxes

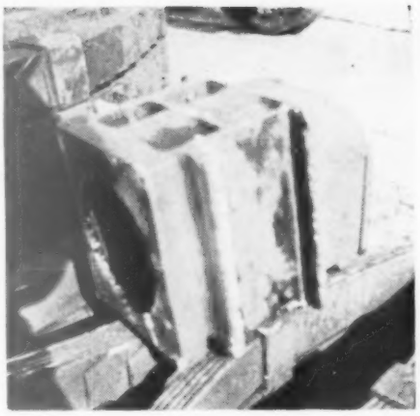
By W. E. PALMER
Hollup Corporation

Although the attachment of wear plates, especially manganese liners, to cast-steel journal boxes might not present any special problems, when the journal box is made of cast iron difficulties arise.

Many railroad and traction companies bronze weld the liner to the cast iron, using the oxyacetylene process. This is a successful application, but it necessitates preheating in order to eliminate stresses that would otherwise crack the box, usually along the base of the flanges.

Preheating can be eliminated by using a low-heat arc-welding electrode, properly coated for the work. This method was used in one job involving about 150 journal boxes for a prominent Eastern railroad. These boxes have been put under test over bad roadbed, and to date they have been entirely satisfactory and the railroad is quite enthusiastic regarding the service the welded boxes are giving.

When using this method, cracking of the boxes caused by welding is unknown, as the amount of heat necessary does not set up excessive stresses, and since the grain structure of the cast iron is not appreciably affected by the relatively small amount of heat, cracks do not develop under normal service. This process of welding is simple and very fast.



Cast-Iron Journal Box With Manganese Liners.

Purdue Announces Welding Conference Program

A timely papers program has been prepared for the twelfth annual conference on welding to be held at Purdue University, Lafayette, Ind., on Thursday and Friday, Dec. 10 and 11. Many firms will be represented with exhibits and demonstrations. All sessions, as well as exhibits, will be held in the Michael Golden Shops. Further details can be obtained from J. D. Hoffman, Department of Practical Mechanics, Purdue University. The program is as follows:

Thursday, December 10

MORNING

8:00 a. m.—Registration, Michael Golden Shops. Exhibits and demonstrations.
10:00 a. m.—"A Welcome," by A. A. Potter, dean of the engineering schools.
What the Exhibitors Have to Show: Brief statements by representatives of exhibitors.
Exhibits and demonstrations.

AFTERNOON

1:00 p. m.—Exhibits and demonstrations.
1:45 p. m.—"Production Welding of Light-Gauge Tubing," by John Douglas, Electrolux Unit Division, Servel, Inc., Evansville, Ind.
"A Survey of the Development of Fusion Welding," by J. M. Jardine, Western Welding & Boiler Repair Co., Chicago, Ill.
"Possibilities in the Further Extension of Arc Welding," by H. S. Card, Welding Division, National Electrical Manufacturers Association, Pittsburgh, Pa.
Exhibits and demonstrations.

EVENING

7:00 p. m.—Exhibits and demonstrations.
7:45 p. m.—"The Electric Welding Arc in Action," by E. W. P. Smith, The Lincoln Electric Co., Cleveland, O.
"The Manufacture, Fabrication and Applications of Enduro Stainless Steels," a sound-movie film, by T. R. Lichtenwalter, Republic Steel Corp., Massillon, O.

Friday, December 11

MORNING

8:00 a. m.—Exhibits and demonstrations.
9:00 a. m.—"The Hard-Surfacing of Metals." (a) By use of the electric arc, by Fred G. Huffman, Huffman Bros. & Gavin, Bluffton, Ind.; (b) by use of the gas flame, by E. F. Smith, Haynes Stellite Co.
"The Role of Electrode Material in Resistance Welding of Ferrous and Non-Ferrous Sheet Metal," by E. I. Larson, P. R. Mallory & Co., Inc., Indianapolis, Ind.
Exhibits and demonstrations.

AFTERNOON

1:00 p. m.—Exhibits and demonstrations.
1:45 p. m.—"Applications of Welding in Railway Repair and Maintenance," by John E. Martin, Beech Grove Shops, New York Central System, Indianapolis, Ind.
"The Art of Welding as Applied to the Automotive Industry," by E. B. Rausch, Studebaker Corp., South Bend, Ind.
Exhibits and demonstrations.

Arc Welding Monel and Nickel

Abstract of paper given at the meeting of the American Society of Mechanical Engineers, in Cleveland, O., Oct. 23.

By F. G. FLOCKE and G. F. SCHOENER
The International Nickel Company, Inc.

SHEET, plate and other rolling-mill products are seldom used in industrial applications as such, but must be fabricated and joined to form a useful piece of equipment. If then a metal is not capable of being readily joined, certainly its usefulness is very definitely limited. Contrariwise, if a metal is quite readily fabricated and capable of being joined by the modern tool, fusion welding, then other things being equal, that metal's usefulness to industry is not so limited.

In the early days, it was customary for those wishing to electric-arc weld certain alloys to purchase bare wire and then give it a thin coating of a mineral flux, which was supplied with the wire in the case of monel and nickel. This procedure of having the customer coat his own electric welding wire as needed did not work out satisfactorily, because of such variables as thickness of coating applied, consistency of flux bath, lack of thorough and complete mixing of flux bath, etc. Steps were taken to supply equipment builders with properly coated electrodes for both carbon- and metallic-arc welding, and much progress has been made since that time.

Included under the general head of fusion welding are oxyacetylene, metallic-arc and carbon-arc welding. The oxyacetylene-welding picture has remained essentially unchanged for the past five years; practices are well developed, and making good oxyacetylene welds in monel and nickel presents no difficulty.

This paper will deal primarily with metallic-arc welding and, incidentally, will make occasional reference to the carbon-arc welding of these two metals, both of which are available in the usual rolling-mill forms.

Ductility at High Temperatures Improved by Mill Practice

Some six years ago saw a rather complete change in the melting and refining practice of monel and nickel. Subsequent to that time the hot ductility of both materials has been much improved. With material of current production it is possible to make free 180° bends through the complete temperature range of 1200° to 2200° F. Material of earlier production was hot-short between 1200° and 1600° F. The improvement in hot ductility as measured by reduction in area was quite marked, there being a rise from about 25% for earlier production, to 50% for current production in tests made at 1800° F. Because of the improved production methods, hot-working of monel and nickel in the forming of heavy equipment no longer requires extremely accurate temperature control, and the metals can now be worked in a temperature range considered dangerous a few years ago. Another important advantage of monel and nickel produced by current methods is freedom from cracking during welding.

About five years ago the manufacture of flux-coated electrodes of monel and nickel was begun. At the same time the study of arc welding these two metals was broadened. Regular cold-drawn monel wire was used for many years for the core wire of electrodes. In the light of present practice, results were only fair, although a few years ago they were considered quite satisfactory. It was found that where a light wash coating of a mineral flux gave only fair arcing characteristics, an improvement in arcing characteristics was obtained where a slagging type of coating was used. The thickness of coating was multiplied several times; but since the thicker coatings were applied by hand dipping, the problem of concentricity became paramount. Attempts at applying several thin coatings to build up a heavier total thickness were mildly satisfactory. It was found also that with these plain dip coatings, a slight amount of porosity still persisted in the deposited weld.

Electrodes Contain Aluminum as Deoxidizing Agent

The usefulness of aluminum as a deoxidizer in nickel alloys was known, but advantage had not been taken of this in welding. Finally it was decided that the use of aluminum in the form of fine wire wrapped in a spiral around the 18-in. length of bare electrode, would serve a twofold purpose: First, it would aid in deoxidation, and, it was hoped, eliminate

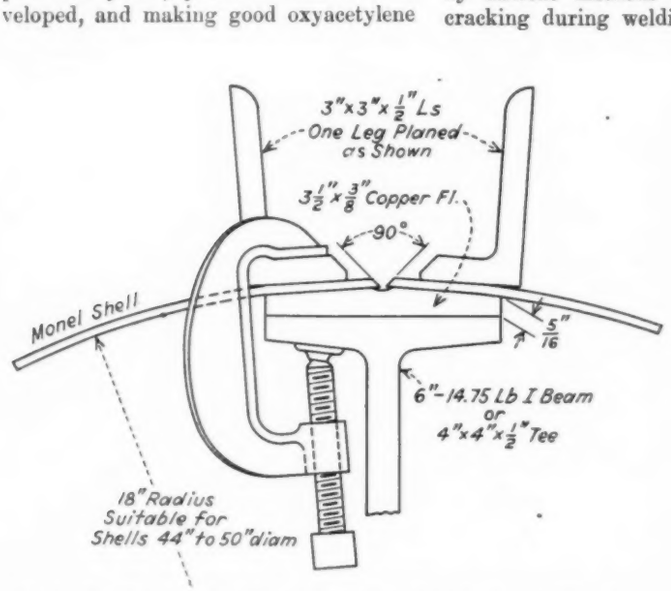


Fig. 1. Jig for Welding Short Lengths of Thin-Gauge Monel and Nickel.

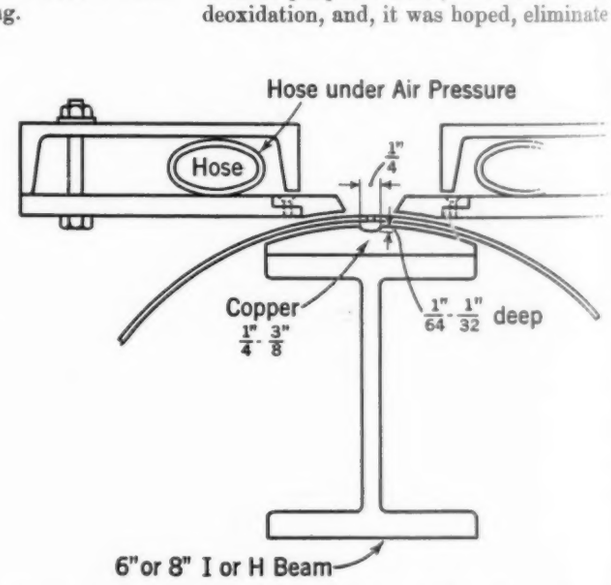


Fig. 2. Jig for Welding Long Lengths of Thin-Gauge Monel and Nickel.

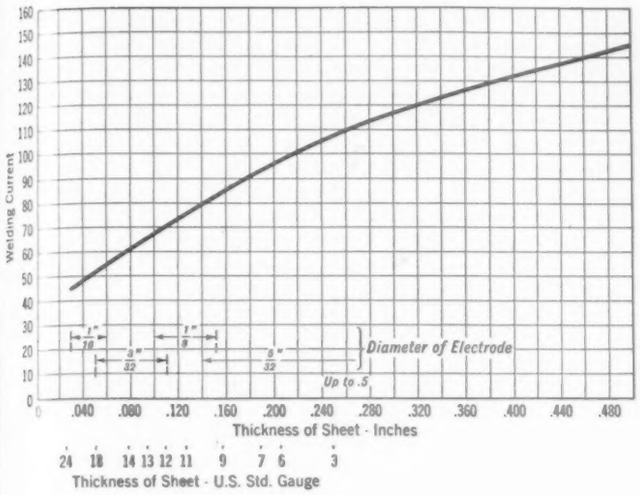


Fig. 3 (Left). Relation Between Sheet Thickness and Current Required for Metallic-Arc Welding of Monel and Nickel.

(The approximate current values given are useful in making a setting on the welding machine, and should be used as a guide only. Such factors as gauge of sheet, electrode diameter, backing material, and jigging or clamping, all affect the current setting.)

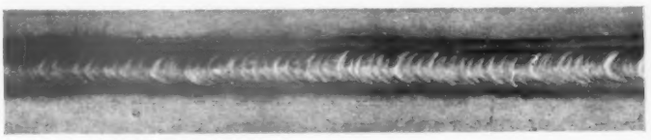


Fig. 4. A Typical Carbon-Arc Weld in Monel.

porosity; and second, the spiral would serve as an excellent support for the flux coating applied by dipping. This procedure worked out very satisfactorily with both monel and nickel and was used for several years. The more recent developments of coating by extrusion were applied, with the result that the extruded monel electrode is commercially available now.

Inasmuch as coating by extrusion does not conveniently permit a metallic spiral aluminum winding, and as the presence of aluminum appeared desirable in or near the molten pool of weld metal, experimental activity was directed along the lines of introducing this element in one of two forms, either in the coating or in the core rod. The latter was found more convenient and a small amount of aluminum in monel wire for welding has been found to be entirely satisfactory from the standpoint of welding characteristics, physical properties, and soundness in the deposited metal.

Up to the present, only the monel electrodes have been coated by extrusion for commercial use. Following the growth of knowledge and experience with the exacting requirements of extrusion coatings, as to pressures, speeds of extrusion, centering and, of great importance, proper drying, the monel electrodes now produced are of highly satisfactory quality. The criteria are, good arcing characteristics and ability to deposit strong, sound, ductile metal consistently under a variety of operating and shop conditions.

Welds Develop Full Strength of Plate Material

The use of a slightly alloyed monel rod, described above, is developing strengths of 70,000 to 80,000 lb. per sq. in. in single-bead and multiple-bead butt joints, metallic-arc welded. This is the range of tensile strengths obtained in plate material.

Higher strengths in the weld metal than in the parent material would hardly be useful, since it is the strength and ductility of the completely welded joint that is of interest to designers, and not merely strengths of plate or weld metal separately.

Monel electrodes and nickel electrodes, both carrying relatively thick flux coatings, require reversed polarity, as do most of the high-strength-steel electrodes. While no attempt has been made to determine the reason why reversed polarity is productive of more satisfactory metallic-arc welds, suffice it to say that by experience it has been found to be more suitable than straight polarity.

Clamping or Jigging Will Restrain Buckling of Thin Sheets

In the metallic-arc welding of sheets of light to medium gauge, between 0.037 and 0.125 in. thick, it has been found desirable to use a means of clamping or jigging to restrain buckling. While this recommendation has been made in connection with monel and nickel welding for many years, industry has sometimes referred to it as an apparent shortcoming of these two metals that their joints must be so prepared prior to welding. However, it is just as desirable in the welding of light-gauge sheet steel. The coefficients of expansion for monel and nickel are practically identical with the coefficient of expansion for carbon steel, which is 0.0000085 in. per in. per deg. F. for the temperature range of 100° to 1300° F.

The use of identical gauges in either monel, nickel, or steel, and identical setups and welding processes, will give essentially the same results as to degree of buckling. With progress in improving the properties of steel weld metal, there has come also an improvement in appearance—that is, freedom from buckling of steel-fabricated pieces, which is due in no small measure to wider use of jigs and clamping devices. Of course, sequence in welding also has been an important factor. No longer can the suggested use of simple jigs be considered a liability in a monel or nickel fabrication, but a case of necessity where close limits must be held and where buckling or warping of surfaces will cause rejection.

For welding longitudinal butt seams, simple jigs such as shown in Figs. 1 and 2 are frequently used. Particularly is this the case where longitudinal joints are to be made in cylinders in which proper alignment of sheet edges is of primary importance and where perfect roundness is necessary.

The jigs suggested for use in butt joints are of greatest value in sheet thicknesses up to about ⅛ in. or slightly thicker. It can be seen that a jig serves two purposes: First, it holds the sheets in line during welding, thus making welding easier and obtaining a joint freer from buckling; and second, the shallow groove in the backing-up strip acts as a mold for the weld metal and permits more uniform penetration, the latter being an important factor where the penetration side of a single-bead joint must be ground and polished flush with the sheet surface. Either or in fact both sides of the welded joint can be ground and polished to a high finish.

On fillet welds, where it is convenient, and certainly on thin materials, it is desirable that an angle be used to back up a joint. It is not necessary to back up corner welds in material greater than ⅛ in. thick.

In many cases, it is uneconomical or inconvenient to use jigs or clamps when welding medium or light gauges. It would be unwise to burden any cost sheet with the cost of jigs the usefulness of which will be extremely limited. However, once jigs of the type indicated in Figs. 1 and 2 are available in any shop, their wide applicability will be readily appreciated even on the ordinary run of sheet-steel work.

Correct Amperage Depends on Many Factors

In the metallic-arc welding of monel and nickel, there are several factors which affect the heat or amperage required for a particular job. Some of

these are the diameter of electrode, the gauge of sheet, the speed of welding and, coupled with the latter, the degree of penetration, type of backing up, whether copper, steel, or unsupported, and, if a jig is used, whether the metal is tightly clamped to it. It is because of these many factors that accurate heats are not readily available. The curve in Fig. 3 gives the approximate relation of sheet thicknesses to current required for metallic-arc welding monel and nickel.

For the lighter gauges, it has been found that beads made without weaving are entirely satisfactory. There is no definite dividing line where straight-line welding should be stopped and weaving begun. The 5/32-in.-thick sheet for butt or lap joints can be used as a convenient dividing gauge above which a slight weave may be found desirable. For fillet welds the approximate dividing line is ⅛ in., but a weave is definitely preferred for sheets above 5/32 in. thick.

Electrode Is Held Vertically or Nearly So

The angle of the electrode, when making butt welds, should be from the vertical position to about 30° from the vertical. The electrode should be about normal to the molten pool of weld metal. This electrode position permits a more uniform flux coverage of the hot or molten metal, and is to be preferred to the practice sometimes found where the electrode position is such as to push molten slag ahead of the welding pool, in the root of the V.

For horizontal, vertical, or overhead welding, practices regularly followed in steel welding are adhered to. Wherever possible, it is naturally desirable that positioning of the work be such that welding is in the flat position or nearly so. Certainly better control is obtained, and unquestionably better weld metal is the result. Position welding can be done, and is being done, on jobs which cannot be moved; and the end results, the physical properties of weld metal, and the appearance of the deposited bead, are entirely satisfactory.

Carbon-Arc Welds May Be Fully Satisfactory

While the carbon-arc process does not receive much mention in the literature, it nevertheless fills a certain need which is difficult to explain but is definitely known to exist. Specifically, carbon-arc welding is frequently applied to monel and nickel sheet in the intermediate range of gauges of 0.037, 0.050 and 0.062 in., and oftentimes heavier. Because of the somewhat slower speed of carbon-arc welding occasioned by the slightly lower rate of heat input, it is possible to control quite accurately the height of bead and degree of penetration. Particularly is this the case where a very small, narrow bead is to be deposited.

Some rather large fume ducts were to be made of 0.050-in. monel sheet, and one type of joint used for field erection was a lap joint in which one sheet was offset, or jogged, slightly. The lap joint was tacked on the outside, then the entire interior was carbon-arc welded to seal the joint and make it air-tight. All carbon-arc welding was done in position, with more work being done in the vertical and overhead positions than in the flat position. A lightly fluxed monel filler rod for carbon-arc welding was used in all cases, with carbon pencils of 5/32, 3/16 and ¼ in. diameter, pointed like a pencil for at least 2 or 3 in. The type of seam obtainable by taking advantage of carbon-arc welding on monel and nickel is shown in Fig. 4. The uniform, ripple surface can be obtained readily with steady hands and experience.

Dry-cleaning equipment of the type shown in Fig. 5 is manufactured of monel sheet of various gauges, but largely of 0.050 and 0.062 in. thicknesses. Butt and corner welds are all made with a 5/32-in.-diameter carbon pencil and a monel carbon-arc welding wire. Here again, uniform appearance and pressure-tightness, without the necessity of grinding and polishing, are required.

Beside being useful for medium-gauge work, carbon-arc welding is equally useful for joining small-diameter tubes into tube sheets. The tubes are left projecting ⅛ to ¼ in. above the surface of the tube sheet, and then either melted down with the carbon arc or a neat fillet deposited, using the lightly fluxed carbon-arc filler rod of appropriate metal composition.

Carbon Point Should Be Kept Sharp and Tapered

Where the small-diameter carbon or graphite pencils are used, close control of the pool of molten weld metal is always obtained if care is taken to retain a sharp, tapered point on the carbon. If the taper is 2 or 3 in. long, and the carbon is gripped in the electrode holder about 4 in. from the tip of the carbon, a fairly uniform wasting away of the carbon will maintain the point, and prevent it from becoming blunt. Just as soon as the end becomes blunt, the arc begins to wander, and the control of the pool is slightly reduced.

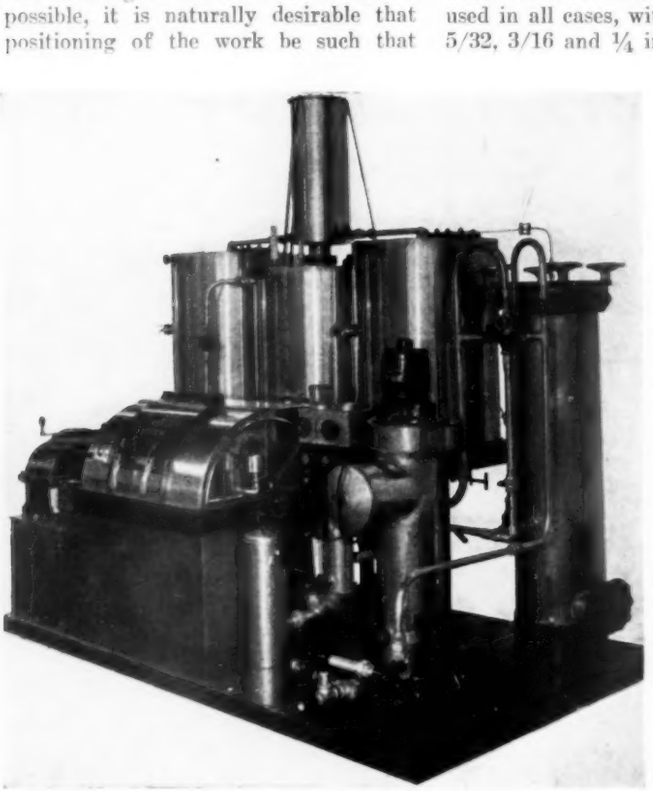


Fig. 5. Dry-Cleaning Unit Fabricated by Welding Various Gauges of Monel.

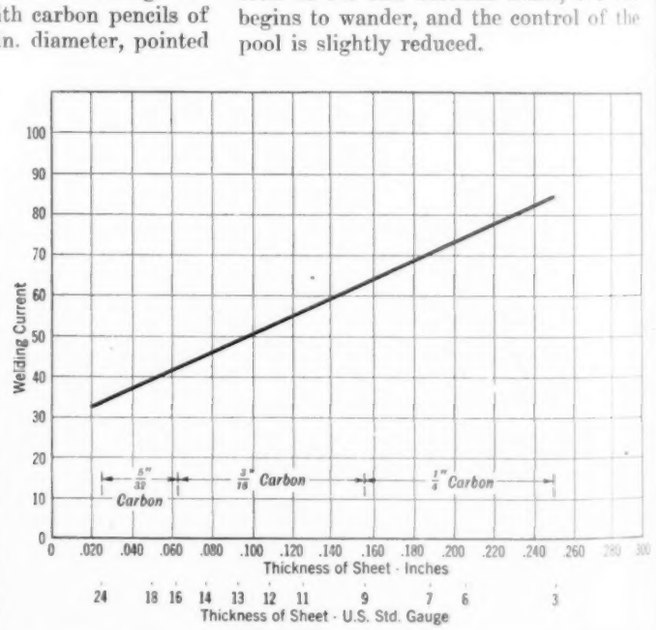
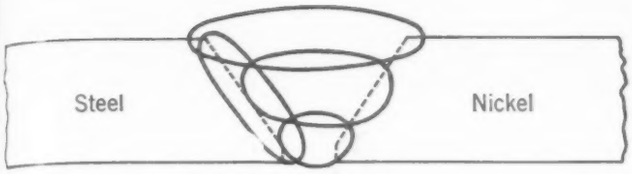


Fig. 6. Relation Between Sheet Thickness and Current Required for Carbon-Arc Welding of Monel and Nickel.
(For welding without backing only. Where copper or other metal backing is used, add 5 or 10 amperes to the values shown.)



Nickel Weld
35° Bevel on each side

Fig. 7. Method of Welding Nickel Plate to Steel Plate.

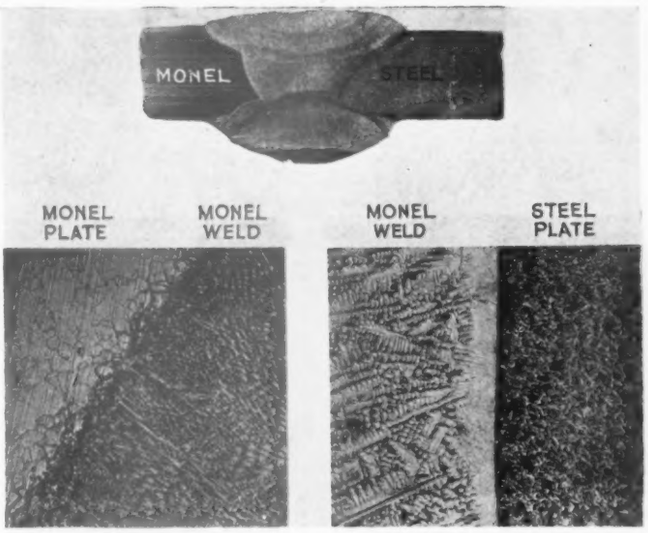


Fig. 8. Photomacrograph and Photomicrographs of Monel Welded to Steel Plate.

For carbon-arc welding, straight polarity is used—that is, the work is positive and the electrode is negative. A steady, uniform and quiet arc is obtainable without undue wasting of the carbon or graphite electrode. If reversed polarity is inadvertently attempted, it will immediately be evident in the hissing, spluttering sound, as well as in the fact that the molten pool will be difficult to control.

Carbon-Arc Length Can Be Varied to Obtain Quiet Arc

The length of the arc is maintained between 1/16 and ⅛ in.—a relatively short arc when compared to the long one required for copper carbon-arc welding. However, the short arc for monel and nickel can be varied slightly—that is, the arc length can be increased or decreased a little to obtain a quiet, smooth arc.

The position of the carbon electrode and of the monel or nickel filler rod, with respect to the molten pool of weld metal, is exactly the same as when oxyacetylene welding in the forehand position—that is, the torch is pointed in the direction of the unwelded seam. The carbon electrode is held at an angle between 30° and 60°, and the filler rod is held at the same angle. The curve in Fig. 6 gives the approximate relation of current to sheet and plate metal thickness.

Carbon-arc welding is useful in certain instances where oxyacetylene and metallic-arc welding cannot always meet exacting requirements of uniformity of appearance and penetration.

It often becomes necessary to join dissimilar metals, such as monel to steel, or nickel to steel. A procedure in successful use for a number of years on 3/16-in. and heavier metal, in joining nickel to steel, is of interest. In the arc welding of a butt joint, the edges are beveled to 35°, and then an overlay, or thin weld, of nickel is deposited on the scarfed edge of the steel. This overlay or weld of nickel, as shown in Fig. 7, really presents a nickel surface, which can then easily be welded to the nickel plate with one or more beads.

Where the correct procedure is followed on butt joints for beveling and for overlaying steel with nickel and then welding with nickel, the results given in Table 1 have been obtained.

Table 1. Test Results of Nickel-to-Steel Butt Joints in 3/16-In. Plate Metallic-Arc Welded.

Type of tensile specimen	Failure	Tensile strength, lb. per sq. in.
Reduced section with weld reinforcements removed.....	In weld	57200
Full-section with weld reinforcements retained.....	In steel	57900

Note: In a free-bend test, the outermost fiber in the weld elongated 9.6% before failure occurred.

Monel Electrode Makes Satisfactory Joint Between Monel and Steel

When welding monel to steel it has not been found necessary to use the procedure of overlaying the steel surface as has been found desirable for welding nickel to steel. In joining ¼-in. monel to steel, a single-V weld was made with a 70° included angle. The butt joint may be welded with a monel electrode, with good results. The macrograph and the micrographs shown in Fig. 8 naturally reveal quite a difference in appearance between the welds and the base metals. Tensile tests of two monel-to-steel welded specimens with weld reinforcement removed gave tensile strengths of 57,750 and 61,500 lb. per sq. in., respectively. Both specimens failed in the steel.

These strengths, since they are normal values for the steel-plate material, are satisfactory for the welding of dissimilar metals, and will suffice where this type of welding must be done. However, the composition of the weld metal is quite unknown, and empirical results are unfortunately the only source yielding sound information.

With a weld on thin sheet, say 0.062 in., it is possible to obtain the strength of the joint, but to attempt to measure the yield point is absurd because actually any value obtained is not a true value for either the sheet or the weld. Also, if the break is in the sheet, the ductility of only the sheet material is determined. With thicker metal, say ⅛ in. or ½ in., the tensile values are easily obtainable again; but yield strengths of welded joints are still of little value, except when all-weld-metal specimens are used.

Ductility Is Determined by Bend Tests

In lieu of suitable ductility values being obtained in a tensile test, recourse has been taken to either a free- or jig-bend test. This type of test has proved quite useful and consists merely of taking a 1½-in.-wide section of weld, in the approximate form of a tensile specimen, and bending the piece so that the stresses all fall in the weld, which is parallel with the bend.

Table 2 gives values of welds recently made as a part of welder approval tests. The weld test plates were allowed to cool to 212°F. before the next bead was deposited. X-ray images of all the plates in connection with this test showed sound and dense welds.

Test plates of ⅛-in. monel plate made up for welder qualification tests are sufficiently large to make available specimens for standard, reduced-section short-

Table 2. Results of Welder Approval Tests on ⅛-In. Monel.
(Courtesy of the Newport News Shipbuilding & Drydock Co.)

Specimen	Condition (machined all sides)	Dimensions of test piece, in.	Tensile strength lb. per sq. in.	Jig bend 180° around ¾-in. radius
A-1	As welded	0.373 × 1.005	84500	....
A-2	As welded	0.380 × 1.015	79400	....
A-3	As welded	0.375 × 1.500	...	Root bend—O. K.
A-4	As welded	0.375 × 1.500	....	Face bend—O. K.
B-1	Heated*	0.376 × 1.015	85700	....
B-2	Heated*	0.376 × 1.020	90400	....
B-3	Heated*	0.375 × 1.500	...	Root bend—O. K.
B-4	Heated*	0.375 × 1.500	...	Face bend—O. K.

*Heated to 750° F. and held for one hour

Fig. 9. Multiple-Bead Metallic-Arc Weld in ⅜-In. Monel Plate.

gauge and long-gauge tensile coupons, and two free-bend coupons. In the tensile specimens, the weld reinforcement is removed and the weld is normal to the applied tension.

Bend specimens are similar to those called for in the A. S. M. E. Unfired Pressure Vessel Code, but inasmuch as the gauges involved are considerably less than the steel-plate thicknesses, the welded monel bend specimens are naturally much thinner. Two types of bend are made—one with the face of the weld in tension, and the other with the root or penetration side of the weld in tension. The purpose is to determine the ductility of the deposited weld metal and the quality of the bond or fusion zone. A bend is marked as "satisfactory" if it has no failure longer than 1/16 in. In all cases the bend is around a 1½-in.-diameter pin.

Table 3 shows results of welder qualification tests on ⅛-in. monel sheet. Each weld was made by a different welder. This was all single-bead work, in which all weld reinforcement was removed before testing in any way. Incidentally, in connection with this same series of tests, a number of x-ray images were made of the welds, which were all satisfactory.

Similar test work was carried out on ⅜-in. hot-rolled monel plate. The weld test plate was set up as a single-V butt joint, with a 70° bevel and a ⅛-in. space between plate edges at the base of the V. Metal from a 5/32-in.-diameter monel electrode was deposited at between 130 and 140 amperes and between 25 and 30 volts. The piece was not allowed to cool between beads. The usual seal weld was deposited in the chipped groove on the back side of the weld. Prior to physical testing, the welded plate was stress-relieved at 1150°F. for the usual one hour per inch of thickness. The x-ray image of the welded seam was free from any porosity and was characterized as "perfect, no defects." The physical properties are shown in Table 4. The photomacrograph of a weld in ⅜-in. monel plate is shown in Fig. 9.

Table 3. Results of Welder Qualification Tests.

(Courtesy of the Newport News Shipbuilding & Drydock Co.)

Number	Long-gage tensile test, lb. per sq. in.	Short-gage tensile test, lb. per sq. in.	Face bend	Root bend
1	81900	81600	O.K.	O.K.
2	83700	77200	O.K.	O.K.
3	79900	83000	O.K.	O.K.
4	75000	75660	O.K.	O.K.
5	74100	75000	O.K.	O.K.

Table 4. Physical Properties of ⅜-In. Monel Metallic-Arc Weld.

(Courtesy of the research department of M. W. Kellogg Co.)

Test	Tensile strength, lb. per sq. in.	Ductility, per cent	Break
Full-section tensile specimen	78500	....	In weld
Reduced-section tensile specimen	77600	....	In weld
Free bend, face of weld in tension, 180 deg. bend	.....	44.4	No failure
Free bend, reverse of weld in tension, 180 deg. bend	.....	50.0	No failure

Welding Procedure for Nickel-Clad Plate

Although by far the greater activity has been with monel, nevertheless a great deal of nickel is being joined by fusion welding. Whenever heavy or large vessels require the use of nickel on their interior surface, solid nickel is not used, but instead a bimetal known as nickel-clad steel. This is flange-quality steel with a thin veneer or cladding of pure nickel on one surface. As the welding of nickel-clad steel is a subject apart from this paper, and as it is already ably covered by a technical bulletin now available, only brief mention of it will be made. In the case of a butt joint, the steel side is beveled with either a V or U groove and that side completely welded in, following regular steel practice. Since a continuous nickel interior is desired, the nickel side of the seam is chipped out with a diamond point or round-nose gouge, and then one or more beads of nickel are deposited with the metallic arc. The strength of a butt joint in nickel-clad steel plate, available in thicknesses greater than 3/16 in., is essentially the same as a properly made weld in steel plate, and designs are based on this value.

In view of the improvements made in the welding of monel and nickel, and of the very satisfactory properties obtained, this method of joining is to be recommended for these two materials.

D. S. Jacobus Receives Morehead Medal

The 1935 award of the Morehead Medal was made to Dr. D. S. Jacobus, by the International Acetylene Association, on Nov. 18, at the annual meeting of the Association held in St. Louis, Mo. The honor was given Dr. Jacobus because of his leadership in the formulation of codes and procedures that have extended the field of acceptance of fusion welding.

Dr. Jacobus' activity in safety goes back to 1914, in which year he became a member of the A. S. M. E. Boiler Code Committee, of which he is now chairman.

In his work on the committee, he encouraged the development and acceptance of welded construction, and took a leading part in formulating rules recognizing pressure-vessel construction by fusion welding, which led to comprehensive rules that have been adopted by various states and municipal authorities, and which removed the bans against fusion welding for boilers and other pressure vessels. Other codes followed, thus further extending the applications of the welding processes.

Dr. Jacobus is a past president of the American Welding Society, and advisory engineer with The Babcock & Wilcox Co., New York, N. Y.

Bids Vary Widely on Welded Dump Scows

Some interesting prices were revealed recently when bids were opened at the U. S. Army Engineers office in St. Louis, Mo., for the construction of three 280-cu. yd. welded steel dump scows. The low figure of $53,820 was submitted by the American Bridge Co., of Pittsburgh, Pa., U. S. Steel Corp. subsidiary. The high bid was approximately 80% greater than that of the American Bridge Co.

The following additional quotations were received: Ingalls Iron Works Co., Birmingham, Ala., $62,800; St. Louis Structural Steel Co., East St. Louis, Ill., $63,000; St. Louis S. B. & Steel Co., St. Louis, Mo., $64,400; Bethlehem Steel Co., Bethlehem, Pa., $64,950; Treadwell Construction Co., Midland, Pa., $74,100; Alabama, D. D. & S. B. Co., Mobile, Ala., $74,186; Dravo Contracting Co., Pittsburgh, Pa., 77,400; Chas. Hegewald Corp., New Albany, Ind., $79,000; Marietta Manufacturing Co., Point Pleasant, W. Va., $94,000.

Historical Series to Be Resumed in December

The series of articles on the history of the oxyacetylene industry, the first of which appeared in last month's issue, is to be resumed in the December issue, at which time it is expected the second article in the series will be completed.

Portable Welding Machine Shop Services Remote Areas . . .

By K. W. COUSE

A REMARKABLY complete and compact portable welding-machine shop was recently completed by Couse Laboratories, Inc., of Taos, N. M., for use in the maintenance of trucks and road-construction equipment. It is far from being simply a collection of equipment loaded on a truck. Instead, the whole outfit has been treated as a single unit: Truck and machine tools are merged together to form one unit designed for greatest utility of all items and with an eye to the convenience and efficiency of the workmen. Equipment includes a d.c. welder, oxy-acetylene torches, air compressor, gun for spraying molten metal, equipment for grit blasting, various electric and air tools, and other devices.

All Machines and Tools Are Made Available by Lifting Sides

All the machines and tools are instantly available upon lifting the sides. The center of operations is the large ¾ in. steel plate overhanging the rear of the truck. This work plate is at a convenient height of 32 in. from the ground and heavy enough to hammer on. It has 90° V at the rear to give clearance at the point of welding to work laid across it. This V is also very handy for flanged pieces and as a rest for vertical work. On the left side is an iron bender and on the right a 7-in. forged steel vise mounted low and solid for work to be welded, bent or hammered. The machinist's vise is quite a different one, mounted on 6-in. channels, 48 in. long, and sliding out from the left center of the cruiser at a jaw height of 41 in. These channels will also support the anvil when it is wanted next to the forge, or they can be withdrawn completely and used to back up the jacks for straightening front axles in place or on work of a similar nature.

The large radial air drill swings out over the work plate, the vise or the ground, as required, and when not needed is swung in under the hydraulic-press frame and forward where it is entirely out of the way. The air drill can be replaced by the 8-in. air grinder with cup wheel, for handling such work as crusher plates and cylinder blocks.

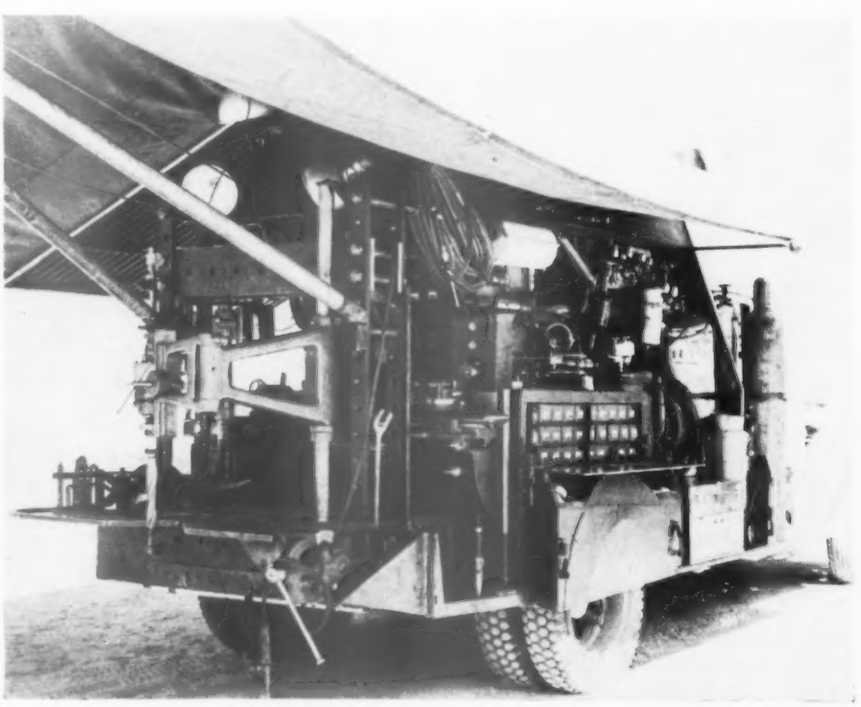
The heavy-duty 18 x 2 in. grinding wheel is mounted on ball bearings and driven by the main motor through a power take-off. It will handle shovel teeth as well as large work.

The forge is built into the body. The firebrick lining is easily removed and set up on the ground in conjunction with the Hauck oil burner for heating large work. The forge operates on charcoal, coal or compressed cylinder gas. It is the center for small gas-welding jobs, especially when arc welding is going on at the rear. The under part of the side doors and body are painted dead black to prevent arc reflection, and men can work at the sides without annoyance while arc welding is in progress at the rear.

Two Complete Gas Welding and Cutting Outfits Carried

A good stock of gas rods will be seen back of the lathe. Gas welding is of course avoided when the job can be done electrically because of the greater expense and to conserve the gas supply for cutting and heating, where it is indispensable. Two complete gas-welding outfits with cutting attachments are carried. One carries 35 ft. of hose, the other 75 ft.

The basis of the outfit is a Diamond T, 2/3 ton chassis with a Hercules 3⅝ x 4¼ in. 6-cylinder motor, with lead-bronze bearings, counterbalanced hardened crankshaft and oil conditioner. This cruiser was built for use in the Rocky Mountan area at an average altitude of 7,000 ft. For work at lower altitudes, and especially if not so completely equipped, a 1½-ton chassis can be used. "Welding cruisers" of greater weight and range are built "from the ground up." The one illustrated is of



Rear View of Truck, Showing Handy Arrangement of Apparatus.

especial interest since welders can adapt ideas from it to their own outfits.

The generator is rated at 300 amperes, 40 volts, and operates at 1,200 r.p.m. The V-belt ratio is 1 to 1. The moderate speed of the gasoline motor and oversize of the generator gives quiet, steady operation without vibration. Slip rings are provided to give 110-volt alternating current for flood lights up to the full capacity of the generator and supplying current for the machine tools. Six hundred pounds of shielded-arc and hard-facing electrodes are carried in easily accessible bins. The reels at the rear of the body will hold 200 ft. each of welding, ground and a.c. power cables. Sufficient cable is carried to work with ease at least 100 ft. from the "cruiser." The main air hose will also reach well over 100 ft.

Air Compressor Carried for Tools and Metallizing Unit

The air compressor is a self-driven unit made up from a model B Ford engine with Gordon Smith compressor head. The output at 7,000 ft. altitude is sufficient to operate the large air drill, rated at 56 cu. ft. per minute, in a satisfactory manner although the actual air delivered is probably about 45 cu. ft. at this altitude. Air tools are used in preference to electric because of their greater power for weight and ease of control, it being possible to drill hard materials with air at very slow speed when an electric drill will burn up the tools. Tapping and bolt threading can be done with the reversible air drills with great ease and speed. The threading dies carried on the cruiser are made with this in mind, being of a uniform square size and with suitable rake and chip clearance.

When the air compressor is run for more than a few minutes at a time the temperature of the air system, because of its small volume, rises to the point where the water separators will no longer dry the air. This is a very serious matter to the metallizing and sand-blast equipment. To remedy this condition, a water tank is mounted on the left front running board through which the air is led in brass-pipe coils. Most of the water in the air is condensed in the submerged bends and is blown or "bled" out.

Front View, Showing Sides Lowered, Ready for the Road.

(The projection in front is formed by the compressed air tank and compressor.)

The sand-blast equipment presented the most difficult problem to solve, since it usually involves a lot of weight and space. It is not a necessity except for the metallizer, to which it is essential. However, the areas to be blasted on machine element work are very small compared to tank and corrosion-resistant jobs and we have found that a 50-lb. (½-cu. ft.) Ruemlin Midget blast generator works very well. A 100-lb. sack of No. 30 steel grit is the source of supply and a rubber lined tent, 7 x 7 ft., pyramid type, with sewed-in bottom, makes a very acceptable blast cabinet to prevent loss of grit. A powerful pressure-vacuum blower is carried for ventilating confined spaces.

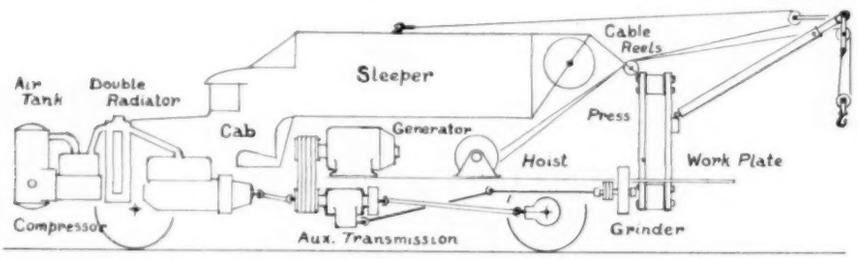
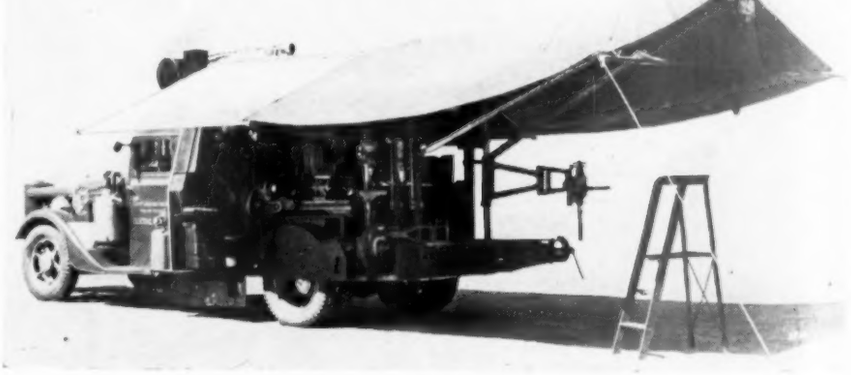


Diagram Showing Locations of Principal Equipment.

The metallizing gun and remote-control gauges are mounted on a panel carried on the right side of the "cruiser." In use, the panel is hung on the platform ladder close to the job, where the gauges, which also function as spare welding gauges, are within easy reach of the operator. The metallizing process fits in very well with the work of the "cruiser." It is used to build up worn areas and bushings where welding would be objectionable because of the heat involved. Connecting rods of any size are easily rebabbitted with sprayed metal without the use of mandrels and can then be bored and faced on the milling machine in a single operation. Press fits are easily restored, often without machining, and there are a multitude of uses to which the unit can be put where the savings are out of all proportion to the amount of metal sprayed on. On the other hand, it is an expensive process when the job requires much metal. The cost of building up a worn bronze bushing is often more than making a new bushing from bar stock. But on emergency repair work the question of time enters largely and when the job can be back in service in hours, instead of days waiting for bronze stock, the cost of the reconditioned part is not important.

A complete stock of steel bolts, nuts and washers is carried on the right side in drawers and bins. There is a stock



The Machine Shop All Set Up and Ready for Business.

rack on the top of the body. Below the cable reels is a bank of drawers containing pipe fittings, copper tubing and fittings, Alemite fittings, key stock, springs and, in fact, an assortment of practically everything needed in repairing trucks, construction equipment and mining machinery.

In a mountain and desert country the raised sides and extensive awning are a great aid in outdoor work. The sides are shown in normal working position in the illustrations. They can be set up to horizontal for greater clearance, or almost closed in stormy weather and in confined locations. Side curtains make a complete tent if required. Clearance lights are provided at front, sides and rear to prevent the "cruiser" from being rammed on night work. The 3-ton crane is used for positioning work too large for the welding table. With booms at full extension, the lift is 18 ft.

Facilities Are Provided for Sleeping and Cooking

A sleeper is provided above the generator room and is entered from the cab. Cooking is done on the forge. The "cruiser" is entirely self-contained and can operate continuously. Two welders form the crew, one resting while the other works. Only 10 minutes is required to set up on the job, and the position of the "cruiser" can be shifted with sides and awning up.

Get "H. O. T." on Welding

By H. O. T. RIDLON

A Wallop at Welding

Just been reading my November copy of *Readers Digest*. And did I get hot under the collar when I read the following paragraph from an article by Elliott Arnold, condensed from the *Nation*, called "The Misused-Car Market":

"Even so serious a thing as cracked motors can be fixed by welding, the signs of which can be covered with grease. But eventually the weld will reopen, and since metal will not take a second welding in the same place, a new motor is needed."

How do you like that? Are we going to sit back and take it? I don't think that is going to help job shops any this winter. And I don't think it is going to help the sale of cast-iron or bronze welding rods, or electrodes, or flux, or equipment both oxyacetylene and arc.

A lot of people who are prospects for good welding are going to read that paragraph and become unsold on welding. I think that we all should write the *Nation* and the *Readers Digest* and ask them to very strongly retract that statement and publish articles on the merits and virtues of welding, written by men in the industry who know what they are talking about. If every one who reads this line of mine will take time to write the editors of these two magazines calling them strongly for that paragraph, we'll get some action. Are you with me?

• • •

A. W. S. Meeting and Exposition

Sure now it was a grand show. Really worth seeing as usual. It would take me much more than my allotted space to tell you all about it. But as I predicted there was much new to see and much to learn. And many very interesting people to meet. I was so busy in our booth that I did not get the chance to listen to any of the lectures that were given under the auspices of the American Welding Society. But that's ok because in the Journal of the Society all the papers that were given are published. So if you weren't there you can read them. And if you are not a member for ten bucks you can become one. And I've always felt that every one in the industry should be a member. I'm on the National Membership committee so if you are interested, as you should be, drop me a postal card and I'll see that you get an application blank.

• • •

And They Grind On

It seems that the opinion regarding preference for flexible-shaft of hand grinders is about even so far. True, I have only had a few replies to my question on the subject last month, only about thirty or so. I'd truly appreciate some more expressions.

• • •

Honest, It's on the Up and Up

Some of the boys have written in saying they thought I was trying to pull a fast one in the September issue about splicing new rubber belts with oxyacetylene. The Linde people published a rather complete descriptive article how to do this job in an issue of *Oxy-Acetylene Tips* some time ago. Ask them, I feel sure they'll tell you all they know about it.

• • •

Do You Know That—

In bronze welding cast iron it is better to chip out the crack instead of grinding? Clipping gives a surface that the bronze tins to better, and you usually do not make as wide a chamfer to be filled with metal.

In bronze welding cast iron you should use as small a tip as possible with a slightly excess oxygen flame? You then heat just a small spot quickly and can get away from it fast with less expansion and contraction trouble. A case of the smaller the better.

In bronze welding cast iron you should make only a flush weld? No reinforcement is necessary because the ductility and tensile strength of bronze are much greater than cast iron, and you will be able to do the job faster with less oxygen, acetylene, and rod—more profit to you.

In bronze welding you should get the spot you want to weld up to a cherry red heat with the inner cone flame and then pull your torch slightly from the work and melt the bronze with the envelope flame? Try it! It should give the finished job the appearance of a rich bronze color instead of the usual brassy color we see so often in bronze welds.

In bronze welding cast iron, a good manganese bronze gives good results? I find that it takes better to the cast iron, and the tensile strength is higher.

In bronze welding cast iron wherever possible you should work slightly up hill? Then the bronze will not roll ahead of your tinning action. This will materially help you in always getting a tight job.

• • •

Make a Salesman Out of the Camera

A good camera in a job welding shop can be made into one of the most useful and successful sales tools you can get, by taking "before and after" pictures and putting them up neatly in your office or in a loose-leaf binder with a short snappy clearly typed description of the job, for your customers to see and ask questions about. It often gives them ideas of jobs they might have you do, that they had no idea could be done. There is an old Chinese proverb that says: "One picture is worth ten thousand words."

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Now That It's Over!

I'll just bet that F. D. R. is mighty thankful that the Fusion Party didn't really get going this year. Anyway I've got to admit that I had my fun. And I wish to report that the treasurer of the Fusion Party is still flat broke. Creditors please note, I'm speaking of the party and not myself. I don't want any of you big-hearted guys running a benefit for me.

• • •

The thought for the month: Your rights are less important than the other fellow's feelings, and your feelings less important than his rights.

Long, Narrow Sections Fabricated to Close Tolerances . . . .

TO FABRICATE long, narrow, box-type assemblies which must be held within close limits as to length and straightness, requires great care to avoid distortion. The use of proper jigs keeps down production costs and aids in aligning the separate sections.

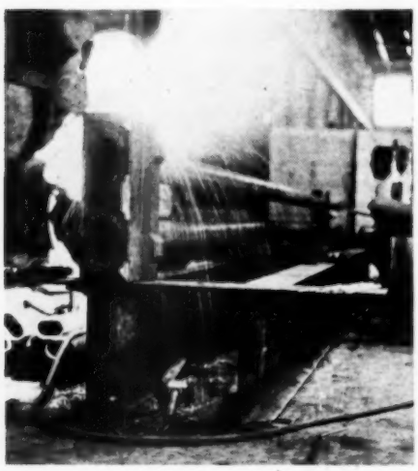
In the manufacture of 96 guides for gates for the Fort Peck Dam in Montana, each guide was formed of four cast-steel sections welded together end to end after being assembled in special jigs. These guides were manufactured by the Pettibone Mulliken Co., 4710 W. Division St., Chicago, Ill., and the welding was in charge of J. C. Kellenberger, departmental superintendent, who also developed the special jigs for assembly.

One of the Roller Guides Lined Up, Tacked and Ready for Welding.

Large Number of Guides Are Involved in Order

Involved in this order were 96 guides, consisting of 32 roller guides, 32 end guides and 32 seal guides, each group of 32 consisting of 16 right-hand guides and 16 left-hand guides. Dimensions and weights were as follows:

Lengths of Individual Sections	Overall Lengths	Assembled Weight
ROLLER GUIDES		
9′-7″, 9′-8″, 9′-8″, 12″, 11′-10″	41′-3″	11,100 lb.
END GUIDES		
9′-7¼″, 9′-8″, 9′-8″, 12″, 11′-4″	41′-3¼″	4,500 lb.
SEAL GUIDES		
9′-7¼″, 9′-8″, 9′-8″, 12″, 9′-10¾″	39′-10″	4,300 lb.



Welding the Tubes Into the "Dummy" Section.

The weights given above include the beams and angles that were attached to the finished pieces.

All sections were of box shape, the end guides and seal guides having an overall cross-section of 9 x 6 in. with 1-in. walls, while the roller guides have a 6 x 18-in. cross-section with 1-in. walls and a 2-in. web separating the two longitudinal chambers.

The specifications required that these guides be made of No. 2 steel, grade 3, hard, 80,000 lb. per sq. in. minimum. The length of each piece had to be kept to within plus or minus ¼ in. of the specification length and the finished guide had to be within 1/16 in. true on one side and within ¼ in. true on the opposite side.

All sections were cast of steel containing about 0.45% carbon, and annealed at about 1,650° F. After cleaning, burning off heads and gates, and rough grinding each section, the drag side (bottom) was trued up on a surface grinder to obtain a foundation or base for setting up.

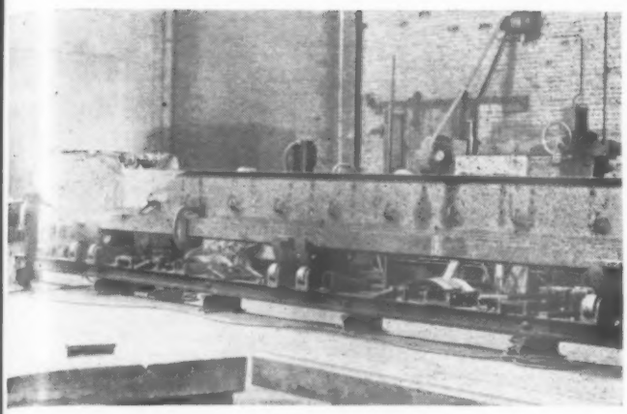
Castings Sawed to Length and Ends Beveled on Milling Machine

All pieces were then sawed to length. The abutting ends were beveled on all four sides on a milling machine to make an included angle of 60°, a ¼-in. unbeveled face being left. In the case of the double sections, or roller guides, the 2-in. web could not be beveled and welded, but this was unnecessary as watertightness between the chambers on each side of the web was not required, though for all the finished guides it was necessary that the casting and welds themselves be watertight.

To accomplish speedy assembly, with due regard to the close tolerances specified, a welding deck was devised consisting of four rings, split in the middle, each ring clamping through its center one of the four long sections making up the guide. Each ring revolves on four idlers mounted on two parallel rails leveled and aligned and provided with hinged parallels which support the sections while being lined up and clamped, and having points symmetrically located so the set-up is facilitated.

The sections were chucked in these rings to a symmetrical point with cap

Each of the Cast Sections Is Clamped in a Circular Jig.



With the Top Half Removed From the Circular Jigs, the I-Beam Is Laid Onto the Guide and Welded in Place.

(Lying on the rails supporting the circular jigs are several channel-shaped clamps for holding the ends of the sections in place prior to tack welding.)

screws. The short section, or "dummy," forming a part of each guide, was inserted in place and held by channel-shaped clamps of the same kind as used for clamping the ends of all the sections. These clamps contain slots through which the metallic electrode was applied for tacking the sections together. After the sections were lined up and tacked, the clamps were removed and the welding operation started.

Joints Are Preheated Before Welding

Before welding, all joints were preheated for about 45 minutes with kerosene blowtorches. Four welders with four helpers worked simultaneously, welding first on top of the guide, then turning the guide 180° by means of lever rods inserted in holes in the rings, and then welding the drag side (bottom). The assembly was then turned 90° and welded on the third side and then turned 180° and the last side welded. The above welding procedure was continued until approximately six layers of welds were deposited.

A 5/32-in. electrode was used on the first bead and a ¼-in. electrode on all other beads. All electrodes were of the shielded-arc type and the oscillating method was used.

The last casting, which is the longest section, of each guide has one side open (top) to allow access to the chamber, or chambers, running longitudinally through the guide. The "dummy," which is the 12-in. casting and adjoins the open section, has welded into it at one end one or two lengths of 3-in. pipe, depending on whether single or double sections are used, each pipe being 29 ft. 8 in. in length and crimped and flattened to approximate dimensions of 2 5/16 x 4 5/16 in. These pipes extend through the chamber, or chambers, of the box-like portion of the guide for electric heating elements, and are welded to the "dummy" before making the assembly.

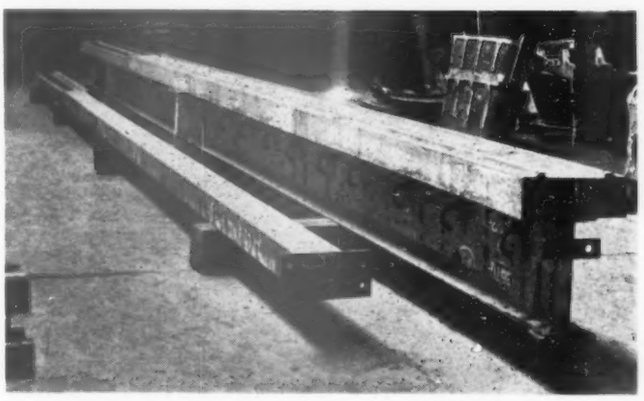
After all sections were welded together, the parallels again were put in position and the assembly left to cool, after which the top halves of the rotating jigs were removed. On the roller guide an 18-in. I-beam with 7⅝-in. flanges was then welded along the top for the entire length, using ⅜-in. beads, 1½ in. long, spaced on 6-in. centers, along the edges of the beam flange. Two operators welded simultaneously on both sides of the beam.

Planer Makes Finished Cuts on Completed Guides

All the completed guides were then taken to a planer and blocked on a level foundation where the finished cuts were made.

After each guide was welded and planed, it was tested for leaks under 30-lb. air pressure for two hours, with a soap solution applied to the outside of the casting and welds.

Angle irons, spaced 2 ft. 4½ in. on centers and running transverse to the casting, were welded to the bottom side for the entire length on the end and seal guides; and along the sides of the open sections were welded angle irons, during the welding of which the end of the guide was packed with wet waste.

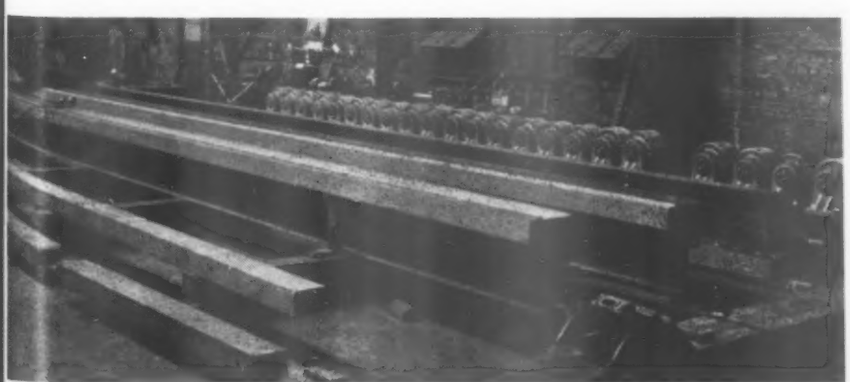


Completed Roller Guide and End Guide.

These angle irons and I-beams, with their attachments, are imbedded in concrete after delivery to the site.

The ends of the guides also were enclosed by plates welded in position.

The open sections of all guides were covered with cast plates mounted with screws, which allow installation of an electric heating element or its withdrawal from the guide chambers.



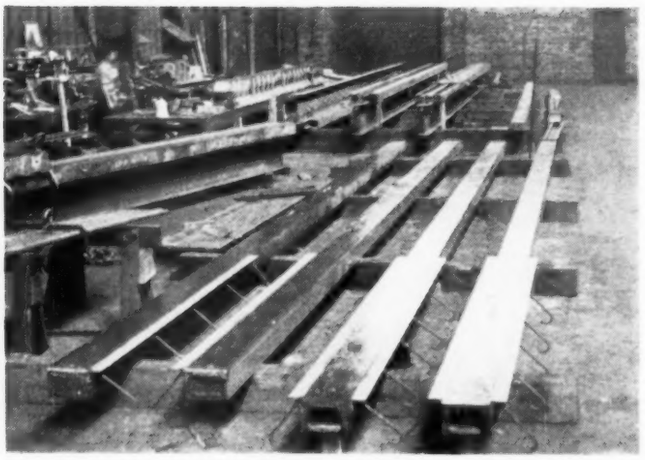
View of Guides and Rollers

(The two guides with I-beams attached are roller guides. In the left foreground are two cast sections with ends beveled for welding, and a completed guide of smaller size. These smaller guides, known as end guides and seal guides, are of box section, while the roller guide is of double box section. The rollers in the background will be attached to a gate, which during raising and lowering will cause the rollers to roll along the side of the roller guide.)

Setting-Up and Welding Time Was Kept to the Minimum

About 1½ hours was required for setting up the castings for each guide. The welding time for the roller guides was about 3 hours each, and for the end and seal guides about 2 hours each. In addition, about 1½ hours was required for setting up and welding the I-beam to each of the roller guides.

Approximately 60 lb. of electrodes was used on each of the roller guides, and approximately 12 lb. on each of the end and seal guides.



End Guides and Seal Guides With Angles Attached.

This job proved the value of jigs for large assemblies of this kind, not only to expedite assembly and fabrication, but also to line up the sections in their relative positions and to minimize distortion due to welding.

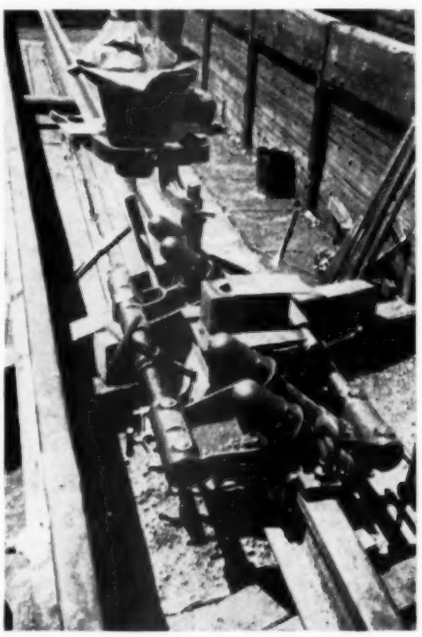
Continuous Welded Track for Montana Tunnels

By C. D. YOUNG
Metal & Thermit Corporation

The thermit-pressure method was employed by the Northern Pacific Railroad last summer in the laying of continuous track in two Montana tunnels, one being the Bozeman tunnel, about 25 miles from Livingston, and the other the Blossburg tunnel, through the Continental Divide near Helena.

Since tunnel clearances and train schedules did not permit the actual welding to be carried on in the tunnel, it became necessary to weld at some nearby town in both cases. For the Bozeman tunnel, the welding was done at Livingston; and for the Blossburg tunnel, at Elliston.

As these towns were some distance from the tunnels themselves, the first problem was one of transportation of the completed welded sections, approximately 4,000 ft. in length, and the unloading of them in tunnels where the clearances were very limited.



Equipment for Welding Rail Joints.

It was finally decided to utilize open-end work cars as a welding bed, and to weld the entire 4,000-ft. lengths on these cars; then to grind to a finish both the surface and the gauge of the rail so it would be ready for installation in track once it was moved to location.

This required a continuous train of 110 of these work cars; and the plan was that once this train carrying the welded length of rail was in position in the tunnel it would be split in the center and each half of the train drawn in opposite directions from underneath the rail. This would permit the rail to fall in place in the center of the existing track, from which position it could be lined over to gauge after the existing rail had been removed.

In order to facilitate the movement of the cars from underneath the rail, old journal boxes (placed upside down) with old car axles were mounted two to a car to act as rollers.

Thermit-pressure welding was carried out in the usual manner while the rails were lying on these cars, and the joints completely finished in every respect.

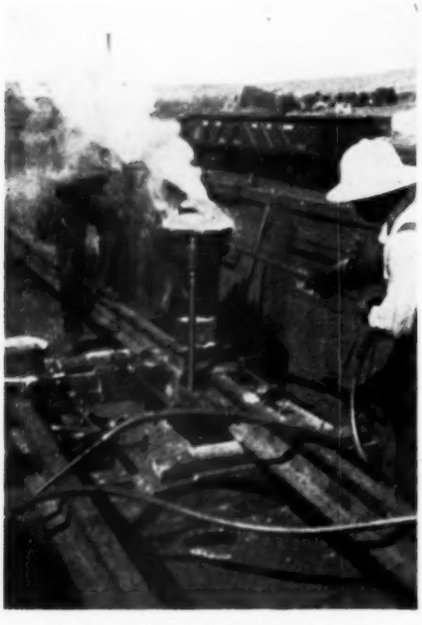
4,000-Ft. Rails Being Transported by Train to Destination.

Two Mallett locomotives, one pushing in the rear and the other pulling, transported the train from the point of welding to the tunnels, it being necessary to negotiate grades as high as 1.8% and curves and reverse curves up to 8° or 9°.

Just before train movement commenced, both extended lengths of welded rail were lined to the center of the train so that they would be the least affected by the curves.

No difficulty was experienced in transporting these welded rail lengths. In fact, the unloading progressed without any hitch whatsoever, and everything went in accordance with plans.

It is interesting that one of the first



Ready to Pour Thermit Mixture.

Passing a Reverse Curve.

View of Part of 110-Car Train Conveying Long Rail Lengths to Tunnel.

comments of the train men, after this rail had finally been placed in service, was in the nature of a complaint. Owing to reasons foreign to that of track, slow orders are in effect in these tunnels and on the first several days the locomotive men complained that they had difficulty in judging their train speed, owing to the absence of the old familiar click of the wheels passing over the mechanical joints.

One of the reasons for welding this tunnel rail is that the dampness in the tunnels cause corrosion of the rail, and engine gases probably also contribute to accelerate corrosion and limit the life of the rail. The effect of this corrosion is more apparent at the joints than elsewhere, since greater efforts are required to maintain the surface and alignment at the joint. It is expected that the life of the rail will be materially increased by the welding, and maintenance costs appreciably decreased.

The excellent planning and cooperation of the engineering department of the Northern Pacific Railroad made possible the welding and transportation of these extreme lengths of rail. Certainly the plans worked out beautifully and the rail was unloaded and placed in service without a minute's delay to any train schedule.

Repairing Pipelines Under Pressure

By M. L. ROGERS

A great many difficulties arise when repairing pipelines under pressure, especially when holding inflammable fluids.

Pipelines need repairing mostly because they have become pitted from rust. Sometimes in an oil country all the creek beds and low lands are saturated with salt water from the oil wells. And one knows what salt water will do to most any metal. Quite often the earth contains chemicals that will react on iron, but worst of all is sulphur gas, which eats the pipe from the inside, quite often beyond repair.

Another class of leaks also very common is leaky collars found on screw lines and usually caused by the pipe crawling under changes of temperature. I have often made repairs when crude oil at 400 or 500 lb. pressure, or gas, or sometimes gasoline, was being pumped through the line.

Some companies dig up the lines and inspect them from time to time. Then the pit holes are built up by arc welding, or if there are a number of pits close to each other, a halfsole is used, this being a half-pipe that fits the outside radius of the pipe undergoing repair. These halfsoles can be bought in extended lengths from several companies, and cut to the desired short length. They are placed in position, then are welded along each edge and end.

Sometimes a section must be cut out and replaced. Then we must shut the pumps down, bleed the line, cut it in two with pipe cutters and plug each end with dirt. After the section is welded the pump will push the dirt out of the line. I would recommend this method for crude-oil lines only; gasoline is too dangerous.

Recently we ran across quite a problem on a pipeline where there was a hole from which the gas was streaming out under considerable pressure. We tried to caulk the leak so a halfsole could be welded over it, but the more we caulked the bigger the hole grew.

This happened to be a 6-in. line, so the welders took an 8¼-in. pipe and swedged it on each end to 6 in. and then split the 8¼-in. section. They then wrapped a tire inner tube tightly around the pipe and shut the leak off to where it could be repaired. The 8¼-in. pipe section fitted easily over the 6-in. line and gave room for the inner tube inside.

When welding the two halves together, the operators slid them back and forth so the weld would not be too close to the rubber. (That is one thing to consider on such work; one must leave the larger pipe sleeve long enough so it can be slid back and forth away from the leak.) After welding the two halves together we welded each end to the 6-in. pipe line, boxing in the leak thoroughly.

We also tie into all lines under pressure—whether gasoline, gas or oil—but this takes a special apparatus to cut into the line or "cut the plug out," as we refer to it.

News of Welded Pipelines

The East Texas Pipe Line Co. plans the laying of a 225-mile welded gasoline pipeline from the East Texas oil fields to the Mississippi River terminal at Natchez, Miss. Plans call for an 8-in. line, which will cost around $1,500,000.

An all-arc-welded pipeline, 20 miles in length and 4½ in. in diameter is being laid by Williams Brothers, Inc., pipeline contractors of Tulsa, Okla., for the California Co. The line will extend between the Quealy Dome oil field, in Wyoming, and Rock River. The project will be completed within a few weeks.

Contracts involving a total of 334 miles of pipeline have been received by H. C. Price, Inc., Bartlesville, Okla., who will electric weld the field joints on the following lines: Ninety miles of 14-in. line in West Virginia, from Clendenin to Hastings, for the Hope Natural Gas Co., welded by the "stove pipe" method, work now completed. Forty miles of 6-in. line near Lusk, Wyo., for the Illinois Pipe Line Co.; general contractors are the White Deer Pipe Line Construction Co. Ninety-four miles of 14-in. line between Rochester and Wellsville, N. Y., for the Godfrey L. Cabot Co.; general contractor is I. C. Little. One hundred and ten miles of 10-in. line in Missouri and Indiana for the Gulf Refining Co.; general contractors are the Kelly Dempsey Co.

Oxyacetylene welding will be employed on the following pipelines, according to reports from The Linde Air Products Co., New York, N. Y.: Ten miles of 6-in. oil line at Russell, Kan., for the Stanolind Pipe Line Co.; will use reconditioned pipe from 20-mile 6-in. line to be taken up near Eldorado, Kan. Ten-mile 6-in. gas line near Cement, Okla., for Oklahoma Natural Gas Co. Fifteen and one-half miles of 4½-in. oil line from Abandoned Peak, Colo., to Chama, N. M., for William E. Hughes Estate. Seven and one-half miles of 6½-in. gas line near Mattfield Green, Kan., for Cities Service Gas Co. Twelve miles of 6-in. natural-gas line from new field near Ravenna, Mich., to Muskegon, for West Michigan Consumers Co. Twenty miles of 6-in. oil line between Talco and Mount Pleasant, Tex., for Lucy Petroleum Co., Dallas.

Large "Y" *and* Reducer Section *Fabricated by* Welding . . .

Photos and diagrams courtesy The Lincoln Electric Company.

By F. G. SHERBONDY,
Vice President, The Biggs Boiler Works Co.

A LARGE Y and reducer section, weighing 32,870 lb. and fabricated entirely of steel, are welded to a design requiring unusual reinforcements, was recently completed by The Biggs Boiler Works Co., Akron, Ohio, and installed in an industrial plant at Dearborn, Mich., for a main mill water-supply line.

This large Y has an overall length of 20 ft. 4½ in. and a diameter ranging between 54 and 60 in. It is designed for arc-welded steel construction, replacing cast iron. This construction provides good hydraulic characteristics, permits desirable flexibility of design to accommodate unusual conditions of installation, insures maximum safety against rupture in service, and provides the required structural strength to resist water hammer and overburden.

In the construction, ½-in. steel plate was used, with all seams butt welded. A total of 600 ft. of welding was required, all done by the shielded-arc process.

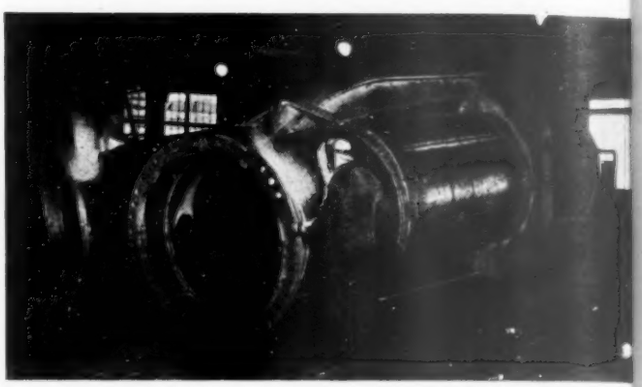


Fig. 2. Fabricating the Large "Y" by the Shielded-Arc Process.

Fig. 1. "Y" Installed in Main Mill Water-Supply Line.

The design of the Y embodies unusual reinforcements, which can be seen in Figs. 1 and 2. The method of determining and computing the shell reinforcement is as follows:

Considering section A-A (see Fig. 3), it is observed that the design of the 60-in. 30° lateral will be statically correct when: First, the thickness of the shell is equal to the thickness required for an ordinary pipe; second, when the tangential tension components T, or their resultant R, are taken care of by a suitable reinforcement at point X. As the load R occurs along line a-a (see Fig. 4), the most economical reinforcement will be a horseshoe beam along a-a. For larger laterals such as this, it will be more economical to support the heels at point Y, with either a ring support or a tension member through the pipe at this point. Referring to Fig. 4, the computation of the shell reinforcement is:

$$T = \frac{pD}{2} \text{ per unit length}$$

$$R = 2T\,\frac{SD}{2L}\,\frac{1}{D/2} = \frac{2TS}{L} = \frac{pDS}{L}$$

per unit length.

This means that the loading is of a triangular shape (see Fig. 5). The computed stress of the reinforcing horseshoe is 14,000 lb. per sq. in. for a working pressure of 90 lb. per sq. in.

In constructing the Y, all parts were first cut to proper size, then rolled and pressed to correct shape and contour. The parts were then assembled by tack welding.

Welding was done in multiple beads by the "step-back" method of welding; that is, the welds were made in short lengths at alternate points along the seam. This method prevented accumulation of stresses and distortion. The completed structure was not thermally stress-relieved, but to aid in reducing stresses all welds were peened. To insure conformity with the procedure control followed by the builder, specimens were cut and tested at intervals.

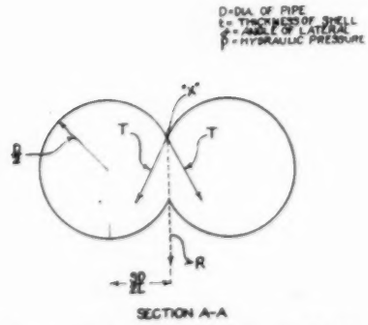


Fig. 3. Design Detail of Arc-Welded Steel Lateral.

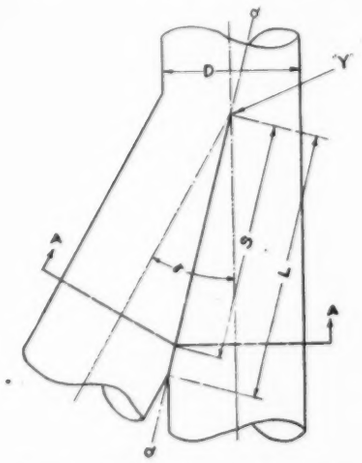


Fig. 4. Loads "R" of Lateral Occur Along Line a-a.

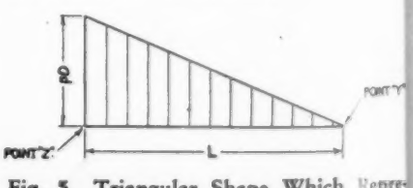


Fig. 5. Triangular Shape Which Represents the Loading of the 60-In., 30-Deg. Lateral.

Following final welding, done with ¼-in. and 5/16-in. shielded-arc electrodes, the section was tested under 250 lb. hydrostatic pressure. No leaks were found and no rewelding was required.

Considerable savings in weight, materials and time were permitted by use of arc-welded plate construction. Weight was kept at the minimum, since in arc-welded steel no connecting members are needed (as in riveted construction) and no excess material is needed (as in cast construction) to obtain necessary strength and rigidity.

Welded Construction Saves 60% in Weight

An all-welded rotor attachment, built by the Bethlehem Steel Co. for the Harnischfeger Corp., is designed to lift a weight of 600 tons and itself weighs 19 tons. It is for use in handling the 500-ton rotors that are being installed at the Bonneville hydroelectric power development. One view of this rotor attachment is shown on the front cover of this issue.

It measures 12 ft. 6 in. in diameter, and is 12 ft. tall. In order to provide the equivalent of a single plate large enough for the heavier of the two horizontal sections at the base, two plates of 3¾-in. thickness were welded together. Massive welding was also necessary where the upper horizontal plates are welded to the shaft of the rotor attachment, which is a forging. The braces are made of ¾-in. and 1-in. plates.

The attachment is temporarily fastened to the rotor, when it is utilized, by means of long bolts, and two 300-ton cranes are employed in lifting the attachment and the rotor. Its forged upper stem mounts in a swiveled crosshead of the main lifting beam, and is carried by roller bearings.

It is estimated that welded design reduced the weight that would have been necessary in a similar unit of cast-steel construction by 60%.

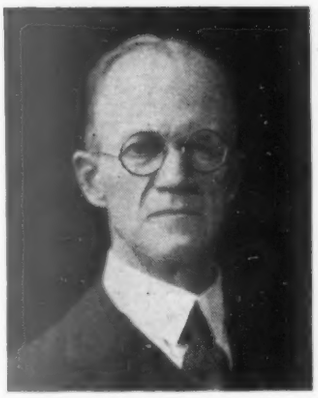
H. M. Hobart Is Awarded Miller Memorial Medal

Henry M. Hobart, for the past 25 years a consulting engineer with the General Electric Co. at Schenectady, N. Y., was presented with the Samuel Wylie Miller Memorial Medal in recognition of his outstanding service in the advancement of welding research at the annual meeting of the American Welding Society, Oct. 19, in Cleveland, Ohio.

Mr. Hobart, an authority on arc welding, was a member of the welding committee formed by the United States Shipping Board at the time of the World War. He is a director of the American Welding Society, and Chairman of the Fundamental Research Committee of the Engineering Foundation Welding Research Board.

Born in Boston, he received his early education in that city and was graduated from Massachusetts Institute of Technology in 1889. For the next five years he was connected with the Thomson-Houston Co. and afterwards with the British Thomson-Houston Co. Mr. Hobart resigned from that company in 1899 to become associated as consulting engineer with the Allgemeine Elektricitats-Gesellschaft, Berlin. Three years later he established an independent consulting practice in London, which he continued for eight years. In 1911 he became a consulting engineer with the General Electric Co., the position he now holds.

He is the author of numerous technical books and holds membership in many technical societies.



H. M. Hobart, Who Was Honored by the American Welding Society.

Progress Photograph of Lower Welded Sections of Rotor Attachment, Showing Hollow Welded Construction at Base.

New York Group Announces Evening Lecture Course

The New York Section of the American Welding Society has arranged with the Brooklyn Polytechnic Institute to present this winter a series of lectures on the fundamentals of welding. The lectures will be given in the Institute, 99 Livingston St., Brooklyn, on Tuesday evenings at 6:45. The first lecture was given on Nov. 10.

The course will comprise ten illustrated talks covering the following subjects: Characteristics of the Welding Arc and Welding Flame, Metallurgy and Metallography of the Welding of Steel, Physical Properties of Welds, Welding in Engineering and Building Construction, Weld Inspection and Supervision, Welding of Alloy Steels and Non-Ferrous Metals, Economics of Welding, and Selection of Welding Processes. The speakers will include such well known authorities as: S. C. Osborne, Wilson Welder & Metals Co.; G. V. Slottman, Air Reduction Sales Co.; J. C. Hodge, The Babcock & Wilcox Co.; G. E. Claussen, Brooklyn Polytechnic Institute; Gilbert L. Fish, consulting engineer; E. R. Fish, The Hartford Steam Boiler Inspection & Insurance Co.; A. B. Kinzel, Union Carbide & Carbon Research Laboratories; L. E. Abbott, Bell Telephone Laboratories; G. H. Holbrook, Federal Shipbuilding & Dry Dock Co.; and J. H. Deppeler, Metal & Thermit Corporation.

The entire series will be free to members of the American Welding Society. Information on enrollment fee for non-members, and other particulars, may be obtained from the American Welding Society, 33 West 39th St., New York, N. Y.

Fusion Welding of Boilers, Pressure Vessels and Piping Under Code Requirements . . .

Reprinted from *Valve World* by permission of the publishers, Crane Co., Chicago.

By ERIC R. SEABLOOM
Engineer, Research Testing Laboratories, Crane Co., Chicago.

THE process of joining metals by fusion welding has been used for a great number of years, but it is only within more recent years that industry, in general, has been willing to accept this method for the fabrication of the more important parts of pressure equipment, such as boiler drums, oil stills, pressure vessels and piping. With the advent of higher pressures and temperatures in vogue today, fusion welding offers many economies in both fabrication and maintenance of equipment.

On the other hand, the use of welded construction has developed a hazard, which only can be overcome by the formulation of safe design rules, strict standards of procedure, development and qualification of skilled welding operators and adequate inspection. This was realized by reliable manufacturers, users of equipment and liability insurance companies, and with their joint support and through the sponsorship of the American Society of Mechanical Engineers, we now have several codes in existence, which incorporate such provisions. These codes are as follows: the A. S. M. E. Boiler Construction Code, the A. S. M. E. Unfired Pressure Vessel Code, the A. P. I.-A. S. M. E. Code for Unfired Pressure Vessels, and the A. S. A. Tentative Code for Pressure Piping. The codes prescribe the minimum requirements that have to be complied with in the fabrication of pressure-containing equipment, including welding, and they all serve very specific purposes.

There appears to be some confusion among fabricators, contractors, piping erectors, sales forces and purchasers as to the scope of these codes, and the purpose of this article is to enlighten those who are not fully conversant with this subject. Only the highlights of the requirements and answers to questions which have repeatedly come to our attention, will be dealt with. Complete details can be obtained by referring to the codes and other sources enumerated.

• • •

A.S.M.E. BOILER CONSTRUCTION CODE

This code is divided into eight sections and was introduced in 1914, but has been revised and added to from time to time to meet the progress in industry.

Section 1—Power Boilers. Section 1 of the A. S. M. E. Code applies to the boiler proper, including connections, safety, stop-check and blow-off valves, the piping up to the valves, as well as the feedwater piping. *Any piping beyond the valves mentioned does not come under this code,* but is covered by the A. S. A. Pressure Piping Code. The A. S. M. E. Code gives rules for determining the thickness of boiler drums, shells, heads and piping, as well as design formulae for nozzle reinforcements, etc. One important item is that the maximum allowable working pressure for feedwater and blow-off piping shall be 80% of that for steam piping, as given by the rules of the code. Consequently, feedwater and blow-off piping must be heavier than steam piping. The welding requirements of Section 1 will be covered later under Section 8, as they are similar.

Section 2—Material Specifications. Complete specifications, covering in most cases physical and chemical properties and test requirements to determine quality, are given for materials entering into boiler and pressure-vessel construction. These include steels for plates, forgings, castings, rivets, bars, bolts, flanges, valves, fittings, tubes and pipes, as well as cast and malleable iron, copper, brass, etc. The majority of the material specifications are similar to those of the American Society for Testing Materials, except where this Society has no corresponding specifications.

When steel boiler plate, heads, pipe, etc. are purchased by the fabricator of a boiler or pressure vessel, it is necessary that these should bear identifying mill stamps; and mill-test reports, giving the physical properties and chemical composition, must be furnished to the inspector. On other materials or parts furnished by the fabricator, it is required that all reasonable facilities be afforded the inspector to satisfy him that the specifications are being complied with.

Section 3—Locomotive Boilers. This section gives rules for the construction of locomotive boilers, including safety valves, fittings and appliances. They are not intended to apply to boilers of locomotives which are subject to Federal inspection and control.

Under the present status of the code only riveted construction is allowed on shells of locomotive boilers. Fusion welding is permitted only on the firebox joints.

Section 4—Low-Pressure Heating Boilers. Section 4 is divided into two parts. Part 1 applies to steel-plate boilers and Part 2 to cast-iron boilers. Steel-plate boilers may be of either riveted or fusion-welded construction. Requirements are stipulated for steam boilers operating at pressures not exceeding 15 lb. per sq. in. and hot-water boilers not exceeding 160 lb., or temperatures in excess of 250° F. For conditions beyond these limits, cast-iron construction is not permitted, but steel-plate boilers can be fabricated, provided the rules for power boilers are complied with.

When fusion welding steel-plate boilers within the above limits, either the electric-arc or the oxyacetylene process can be employed, the only requirement being that the welded joints should be of sound metal thoroughly fused and must exceed the thickness of the plate. Although the code does not specifically state that qualified welders are necessary, it is advisable for the shop to qualify the welding operators as some insurance underwriters performing shop inspections, such as the Hartford Steam Boiler Inspection and Insurance Co., require this. In this case weld-test requirements are similar to those prescribed in

Paragraph U-70 of Section 8 on Unfired Pressure Vessels, which will be described later. It is also necessary that every welded steel-plate boiler be inspected by an authorized inspector at least three times during its construction.

Hot-water boilers that are to operate at working pressures not exceeding 30 lb. per sq. in., and all steam-heating boilers, shall be subjected to a hydrostatic test of 60 lb. per sq. in. Hot-water boilers that are to operate at pressures beyond 30 lb., shall be tested to a hydrostatic test of 1½ times the maximum working pressure.

After completion, all steel-plate boilers must be stamped with the proper symbol, including the manufacturer's name and the maximum allowable working pressure.

Section 5—Miniature Boilers. Miniature boilers generally use gas or electricity as the heating medium and are mostly employed in process work or other applications where relatively small quantities of steam are required. The rules govern both riveted and welded construction when the following limits are not exceeded: 16-in. inside diameter of shell, 42-in. length of shell, 20 sq. ft. of water-heating surface and 100 lb. per sq. in. working pressure. When any of the above limits are exceeded, the rules for power boilers shall apply.

The manufacturer must qualify the welding operators before constructing miniature boilers, and the welding requirements are similar to those prescribed by Section 8, Paragraph U-69, on Unfired Pressure Vessels.

Miniature boilers of fusion-welded construction shall be tested to a hydrostatic pressure equivalent to 3 times the maximum working pressure, and while subject to this pressure shall be given a thorough hammer or impact test. This test consists of striking the shell and heads along both sides of all welded joints with a long-handled hammer, using sharp swinging blows.

Section 6—Rules for Inspection. This section outlines procedure of inspection, which the inspectors should observe in examining materials, workmanship and construction, to determine that all the requirements of the code are complied with. Rules are also stipulated for periodical inspection of boilers in service.

Section 7—Care of Power Boilers. A suggestive set of rules is compiled in this section to assist operators of steam plants in maintaining their equipment in as safe condition as possible.

A. S. M. E. UNFIRED PRESSURE VESSEL CODE

Section 8—A. S. M. E. Unfired Pressure Vessel Code. Rules are formulated in this section for the construction of cylindrically shaped unfired pressure vessels, which may be fabricated by means of riveting, fusion welding, forge welding or brazing. However, limitations are placed on working pressures and temperatures, depending upon the method of fabrication employed. The rules are not intended to apply to piping beyond the pressure vessel, but do cover pipe connections attached directly to the vessel, including flanges. Design formulae for determining thickness of shells, dished and flat heads and size of nozzle reinforcement, are also given.

A very comprehensive set of rules has recently been added to this section of the code for the construction of vessels subject to external pressure. These include notably the design of stiffening rings, which may be attached either internally or externally to the shells to prevent collapse.

Three distinct classifications of fusion welding requirements are incorporated in Section 8, as covered by Paragraphs U-68, U-69 and U-70.

Vessels constructed in accordance with Paragraph U-68 (sometimes referred to as Class 1) may be used for any purpose without any pressure, temperature or shell thickness limitations.

Vessels constructed in accordance with Paragraph U-69 (sometimes referred to as Class 2) may be used for a maximum pressure of 400 lb. per sq. in. and a maximum temperature of 300° F. if containing liquids, or 700° F. if containing steam or other gases, except lethal gases or liquids, provided the shell thickness does not exceed 1½ in.

Vessels constructed in accordance with Paragraph U-70 (sometimes referred to as Class 3) may be used for the storage of gases and liquids, except lethal gases and liquids, at a maximum pressure of 200 lb. per sq. in. and a maximum temperature of 250° F., provided the shell thickness does not exceed ⅝ in.

The rules under these three classifications do not prescribe the welding technique to be followed, nor the process to be employed, but do specify the physical properties to be met and how they shall be determined. However, it is generally customary for fabricators to develop their own specifications and procedure controls for the method of welding they employ. These are subject to the approval of the state, municipal or liability insurance inspector doing the shop inspection before the welding operators demonstrate their ability to weld in accordance with the fabricator's specifications. The specifications must include, in the case of electric-arc welding, the types of grooves used for the various plate thicknesses, number of passes, size of electrode for each pass and current characteristics for each diameter of electrode. If the specifications are for oxy-acetylene welding, they must cover the type of grooves, size of rod for each plate thickness and welding-tip sizes, gas and oxygen pressures for each diameter of rod.

Paragraph U-68 (formerly known as Class 1). As the welding requirements of Section 1 on Power Boilers, Paragraph P-101, are similar to Paragraph U-68 of Section 8 on Unfired Pressure Vessels, they will be described together.

When welding a shell of a pressure vessel or a drum of a power boiler, it is required that test plates, of the same analysis of steel as the shell or drum, be attached to each end of the shell in line with the longitudinal seam. The seams in the test plates are welded as a continuation of the seam in the shell itself. By following this procedure, assurance is obtained that the technique used on the test plates is the same as that used on the vessel.

From the test plates several types of coupons are cut, machined and tested, thus resulting in a qualification test on the welder for each vessel built. A 0.505-in. diameter tensile-test bar and a density-test bar must be taken from the weld proper. The tensile strength of the 0.505-in. bar must be at least equal to the minimum tensile strength of the shell plate and the elongation in 2 in. must be at least 20%. The density test bar must show a minimum specific gravity of 7.80. In addition, a reduced-section tensile-test bar is required and machined in such a way that the load is concentrated at the welded joint, resulting not only in a test on the strength of the weld metal itself, but the fusion zone and the adjacent areas in the plate as well. It is required that the tensile strength of this bar be at least equal to the minimum required for the plate. It is also necessary to make a bend-test bar transverse to the welded joint. This specimen shall be bent cold under free-bending conditions until the elongation on the outer fibers of the weld is equivalent to at least 30%, without any cracks being observed on the convex surface of the bar.

All longitudinal and circumferential welded joints of a U-68 vessel or a drum of a power boiler must be examined their entire length by the x-ray or gamma-ray method of radiography. This type of examination gives a positive record of the presence of defects in the weld metal, particularly porosity and slag inclusions. If the defects exceed the maximum stipulated in the code, the welds will be rejected. Radiographic examination of nozzle welds is not required.

Because of the strain set up during welding, it is required that all welds be stress-relieved, including nozzle welds, by heating the vessel as a unit or in sections to a temperature of at least 1,100° F. for one hour per inch of metal section. The structure should then be

allowed to cool slowly in a still atmosphere.

Paragraphs U-69 and U-70 (formerly known as Class 2 and Class 3, respectively). Since the welding requirements of Section 5, Paragraphs MA-1 to MA-4 on Miniature Boilers, are the same as Paragraph U-69 of Section 8 on Unfired Pressure Vessels, and as the provisions of Paragraph U-70 are almost identical, they will be dealt with simultaneously.

When fabricating vessels in accordance with the above-mentioned paragraphs or classes, the welders must pass qualifying tests and the fabricator shall be responsible for the quality of the welding done by his organization under his specifications and procedure control. The qualifying tests are generally witnessed by an inspector representing an insurance company engaged in shop inspection. The tests of welders are effective for a period of six months only, at the end of which time a repetition of the tests shall be made by the fabricator and the results forwarded to the insurance company for approval. However, if the welders are regularly employed on work embracing the same process and type of welding, the qualifying tests may be effective for a period of one year.

In making tests for U-69 vessels or miniature boilers, the test plates shall be ¼, ⅝ and 1½ in. thick, unless the maximum thickness employed in construction is less than 1½ in., in which case the heaviest materials used may be substituted for the 1½-in.-thick plate. The test plates for U-70 vessels shall be ¼ and ⅝ in. thick. The welding grooves in the plates and the welding of the test plates shall be identical to actual construction. From the test plates four types of test specimens are cut, machined and tested as prescribed in this code.

Two full-section tensile-test coupons are required and they should fail in the plate if the weld reinforcement is retained. If failure occurs in the weld metal or along the line of fusion between the weld metal and the plate, then the tensile strength should not be less than the minimum specified tensile range of the plate used for U-69 vessels. However, for U-70 vessels the tensile strength shall not be less than 90% of the minimum of the plate used. Two reduced-section tensile-test coupons are also required and the tensile strength of these shall not be less than 95% of the minimum specified range of the plate for U-69 and 85% for U-70 vessels. It is also necessary to make two bend-test specimens, which should be bent cold under free-bending conditions until the elongation on the outer fibers of the welds is equivalent to at least 20% for electric-arc welding and 15% for oxy-acetylene welding, without any cracks appearing on the convex surfaces of the bars, in order to meet U-69 requirements. The elongation of the welds for U-70 shall not be less than 10% for either electric-arc or oxyacetylene welding. It is also necessary to determine the soundness of the welds by breaking two notched bars, by means of a sudden blow or blows, through the welded section. The fractures should show complete penetration, and absence of oxide or slag inclusions, and the porosity in the weld cannot exceed six gas pockets per square inch of the total area of the fractured surface, providing the maximum dimension of any such pocket is not in excess of 1/16 in. A test of this nature is not required for U-70.

Fusion-welded vessels constructed in compliance with Paragraph U-69 shall be stress-relieved where both the wall thickness is greater than 0.58 in. and the shell diameter is less than 20 in. and for other wall thicknesses and shell diameters where the ratio of the diameter to the cube of the shell thickness is less than 100. Vessels not requiring stress-relief, based on the above rule, if provided with nozzles having diameters less than 10% of the outside diameter of the shells, need not have the nozzle attachments stress-relieved. However, if these nozzles are reinforced, or they exceed 10% of the outside diameter of the shells, then the nozzle connections must be stress-relieved. The stress relief shall be accomplished by heating the vessel as a unit or in sections to a temperature of at least 1,100° F. for one hour per inch of metal section. The structure should then be allowed to cool slowly in a still atmosphere. U-70 vessels, including their nozzle connections, need not be stress-relieved.

Hydrostatic and Hammer Tests on Pressure Vessels. All fusion-welded pressure vessels and power boilers shall be subjected to a hydrostatic pressure of not less than 1½ times the maximum allowable working pressure. In addition, it is necessary that all pressure vessels be given a thorough hammer or impact test while subject to this pressure. The impact test consists of striking the shell and heads along both sides of all welded joints at 6 in. intervals with a hammer, using sharp swinging blows. Following the impact test, the pressure within the vessel should be raised to twice the working pressure and held for a sufficient time to allow for complete inspection of all welded joints and connections, in order to determine if any defects are present. Locomotive boilers need only be tested to a pressure of 1¼ times the maximum working pressure.

Inspection and Stamping. All power, locomotive and miniature boilers, as well as all three classes of pressure vessels, must be inspected during construction and final test, as outlined specifically in the various sections of the code. After completion they shall be stamped in the presence of the inspector with the proper symbol for each type of boiler or pressure vessel. The stamping should be applied directly to the head or shell or to a metal plate attached permanently thereto, which should include the manufacturer's name, serial number, maximum working pressure and the year built. It is also necessary that a data report, describing the construction, be filled out by the manufacturer and certified by the inspector. Copies of the report must be furnished to both the insurance company performing the inspections and the authorities of the localities in which the equipment is to be installed.

When parts of a boiler or pressure vessel are fabricated by a shop other than the manufacturer responsible for the completed assembly, such parts must be inspected and a manufacturer's partial data report, certified by the inspector, must be furnished.

Some states and municipalities require that boilers and pressure vessels be registered with the National Board of Boiler and Pressure Vessel Inspectors, in which case "National Board" stamping must be included and the data report should be cleared through the secretary of this organization.

The inspections can be conducted by state, municipal or insurance inspectors, but the latter generally make the majority of shop inspections. If a boiler or pressure vessel is to be stamped "National Board," then the insurance inspector must hold a National Board Commission.

Adoption and Enforcement of A. S. M. E. Code. A number of states and cities have adopted various sections of the A. S. M. E. Boiler Code. When boilers or pressure vessels are built for installation in these localities, it is very essential that all the requirements of the code be complied with, including the employment of qualified welding operators and inspection; otherwise they will not be accepted. It is also advisable to follow this procedure when insurance is required by purchasers of such equipment in non-code localities.

In order to insure uniformity in the enforcement of the code, and secure interchangeability between political subdivisions of the United States, and also provide a central clearing house for the filing of manufacturers' data reports, the National Board of Boiler and Pressure Vessel Inspectors was organized. This Board is composed of the chief inspectors of the states and municipalities that have adopted the code. One important function of the National Board is to select competent inspectors, through rigid examination, thus insuring states or cities that boilers or vessels stamped

"National Board" comply fully with the code.

The accompanying table gives a list of states, cities, districts, territories and zones where the various sections of the A. S. M. E. Code have been adopted and also the localities where National Board stamping is required and accepted.

Status of A.S.M.E. Boiler Construction Code

Code States, Districts, Zones, Territories and Cities	Sect. 1 Power Boilers	Sect. 4 L.P. Heating Boilers	Sect. 5 Miniature Boilers	Sect. 8 Unfired Press. Vessels	National Board Stamping
Arkansas	A	C	A	C	D
California	A	A	A	A	D
Delaware	A	A	A	C	D
District of Columbia	A	A	A	A	B
Indiana	A	A	A	A	B
Maine	A	?	A	?	B
Maryland	A	C	A	A	B
Michigan	A	A	A	C	B
Minnesota	A	A	A	A	B
Missouri	B	C	C	C	B
New Jersey	A	A	A	A	D
New York	A	C	A	C	D
North Carolina	A	?	?	?	B
Ohio	A	A	A	A	D
Oklahoma	A	C	A	C	B
Oregon	A	A	A	A	D
Pennsylvania	A	A	A	C	B
Rhode Island	A	A	A	A	B
Utah	A	A	A	A	D
Washington	B	B	B	B	B
Wisconsin	A	A	A	C	B
Hawaii	A*	A*	A*	A*	E
Panama Canal Zone	A	A	A	A	E
Chicago, Ill.	A	A	A	A	D
Detroit, Mich.	A	A	A	A	B
Denver, Colo.	A	A	A	?	B
Erie, Pa.	A	A	A	C	B
Evanston, Ill.	A	A	A	A	B
Houston, Tex.	A	A	A	C	B
Kansas City, Mo.	A	C	C	C	B
Los Angeles, Cal.	A	A	A	A	D
Memphis, Tenn.	A	B	B	B	B
Nashville, Tenn.	A	A	A	C	B
Oklahoma City, Okla.	A	?	?	?	B
Omaha, Neb.	A	A	A	A	B
Parkersburgh, W. Va.	A	C	C	C	B
Philadelphia, Pa.	A	A	A	C	B
San Francisco, Cal.	A	A	A	A	D
Scranton, Pa.	A	A	A	C	B
Seattle, Wash.	A	A	C	C	B
Spokane, Wash.	A	A	?	?	B
St. Joseph, Mo.	A	C	C	C	B
St. Louis, Mo.	A	A	A	A	B
Tampa, Fla.	A	C	C	C	B
Tulsa, Okla.	A	?	?	?	B

A—Adopted
B—Accepted
C—No jurisdiction.
D—Required
E—Not required
*—Hawaiian Sugar Planters Ass'n & other large interests.
?—Status unknown

The information in the above table was compiled from data published by the National Bureau of Casualty and Surety Underwriters, the American Uniform Boiler-Law Society and the National Board of Boilers and Pressure Vessel Inspectors. The National Bureau of Casualty and Surety Underwriters' booklet also lists states and cities that have their own construction rules.

* * *

A.P.I.-A.S.M.E. CODE ON UNFIRED PRESSURE VESSELS FOR PETROLEUM LIQUIDS AND GASES

The joint A. P. I.-A. S. M. E. Unfired Pressure Vessel Code was issued in 1934, as a result of contentions offered by the petroleum industry, that their peculiar conditions were so different from those covered by Section 8 of the A. S. M. E. Boiler Code, on unfired pressure vessels, that they should be exempted from its provisions. The rules of the A. P. I.-A. S. M. E. Code have been carefully formulated to cover the special conditions required by petroleum pressure-vessel service. These rules are greater in scope than those of the A. S. M. E. Unfired Pressure Vessel Code, as in addition to design and construction requirements, they provide for periodic inspection, outline methods to be followed in making field repairs, and the procedure to be used in determining the allowable working pressure throughout the life of the vessel. Rules are also given for determining the allowable working pressure of petroleum vessels constructed prior to the adoption of this code.

The A. P. I.-A. S. M. E. Code rules for design and construction cover fusion-welded, riveted and seamless forged vessels made of carbon steel for temperatures not exceeding 1,000° F. The code does not govern design of piping beyond the vessel, but does cover the pipe connections and nozzles attached directly to the vessel, including their reinforcements and flanges.

The general design requirements of the A. P. I.-A. S. M. E. Code are somewhat different from those of the A. S. M. E. Code for Unfired Pressure Vessels, especially in reference to shell- and head-thickness computations and nozzle reinforcements. In the A. S. M. E. Code three classifications of fusion-welded vessels are covered, each class having different working-pressure and temperature limitations. However, in the A. P. I.-A. S. M. E. Code there is no distinction of this kind, but a system of construction factors has been worked out which determines the final joint efficiencies, depending upon the grade of steel, type of welded joints, radiographing and stress-relieving.

Although radiographing of welded joints is not required by this code, a higher construction factor is allowed when radiography is employed. However, stress-relief is required on vessels where the ratio of the inside diameter of the shell to the cube of the wall thickness is less than 100, and also when the wall thickness is greater than 1¼ in., but a greater construction factor is allowed for stress-relieving. Vessels that do not require stress-relief, based on the above rule, if stress-relieved, may also take the higher factor. Stress-relieving is carried out by heating the vessel as a whole or in sections to a temperature of at least 1,100° F. for one hour per inch of metal section. The structure should be cooled slowly in the furnace to 600° F., after which it can be cooled in still atmosphere. As a result of employing radiography and stress-relief, the material can be reduced in thickness.

Welders are required to pass qualifying tests by making one test plate for each vessel built. The plates are to be of the same analysis and approximate thickness as the shell, and the welding grooves, procedure and technique shall be the same as employed in the actual construction of the vessel.

Five types of test specimens are required for double-butt-welded and single-butt-welded joints, whereas only two types of specimens are necessary for all lap joints with fillet welds. The specimens are cut, machined and tested in a similar manner to those described in the A. S. M. E. Code. The full-section or reduced-section tensile-test specimen shall have a tensile strength that is not less than the minimum specified tensile range of the plate multiplied by 1.1 times the final joint efficiency determined by the construction factors. An all-weld-metal tension-test coupon can be substituted for the reduced-section tensile-test coupon, and this shall have a tensile strength at least equal to the minimum tensile range of the plate, and the elongation in 2 in. must be at least 15% for unstress-relieved welds and 20% for stress-relieved welds. The elongation of the free-bend-test specimens shall be equal to 20% for unstress-relieved welds and 30% for stress-relieved welds. The reverse-bend-test coupons should be bent to determine if any lack of fusion prevails at the bottom of the welds. The requirements for the nick-break tests are identical to those of the A. S. M. E. Code, Section 8, Paragraph U-69.

All fusion-welded petroleum vessels shall be subjected to a hydrostatic test of 1½ times the maximum allowable working pressure, with the exception of vessels that have component parts, the strength of which cannot be computed with any degree of accuracy, and also vessels that are not capable of supporting the weight of the water within the shell. The code outlines specific tests for such vessels.

After holding the test pressure for a sufficient time to permit examination of all joints for any leaks, the pressure shall be lowered to 1¼ times the working pressure and all welded joints must be given a hammer or impact test, as described previously on A. S. M. E. pressure vessels. Following the hammer test the pressure should again be raised to 1½ times the working pressure and a further examination made as to the tightness of all joints.

Stamping and Inspection. After completion, each vessel shall be stamped with the the official symbol of the A. P. I.-A. S. M. E. Code, as well as the manufacturer's name, serial number and year built, either on the vessel or a name plate permanently attached to the vessel.

The purchaser may employ an inspector from his own staff or designate an insurance company inspector to perform all the shop inspections during construction and final test of the vessel. It is also necessary that a manufacturer's data report be filled out, stating the details of construction, and a copy of this report shall be furnished to the purchaser. At present the only means for enforcing the A. P. I.-A. S. M. E. Code is through the shop inspections, as the states and cities have not yet taken any jurisdiction over this type of equipment.

* * *

AMERICAN STANDARDS ASSOCIATION TENTATIVE CODE FOR PRESSURE PIPING

This code was introduced in 1935 to serve as a standard for materials specifications, dimensions, design, methods of fabrication, erection and testing of component parts and completed piping systems. The code is divided into six sections as follows:

Section 1—Power Piping Systems. Section 1 covers design, manufacture, test and installation of piping and its component parts for steam-generating, central heating and industrial plants. It is intended to include all steam, water and oil piping forming a part of these plants, but does not include heating piping in buildings, whether steam or hot water, when the pressure does not exceed 15 lb. gauge, central and district heating distribution systems, gas, air and refrigerating piping, drains, plumbing, sewers, sprinkler systems, hydraulic pressure tools or equipment and industrial process piping for fluids not mentioned above. All valves, fittings and piping for boilers, as prescribed in the A. S. M. E. Power Boiler Code, are considered as a part of the boiler installation and therefore are outside the scope of the Pressure Piping Code. Economizers, heaters, tanks, and other pressure vessels are not covered by this code, but connecting piping must meet its requirements.

Section 2—Gas and Air Piping Systems. This section pertains to the design, manufacture, installation and test of piping and its component parts for conveying air, fuel gas and illuminating gas, such as city gas distribution systems, cross-country transportation systems, piping in gas-manufacturing plants, in air- or gas-compressing stations and in processing plants. This section does not apply to air piping below 30 lb. per sq. in.; pipe connections which are a part of equipment or apparatus; piping lined with refractory material for conveying hot gases; piping used for conveying refinery process gas in oil refineries and for sewer gas and ducts for waste gases and ventilation; casing, tubing and pipe used in gas or oil wells and natural-gas field gathering systems outside the boundaries of cities and villages and domestic gas piping systems.

Section 3—Oil Piping System. This section covers requirements and recommended practices for the design, manufacture, test and installation of oil piping systems used in the production, transmission and refining of petroleum. It does not apply to casing, tubing or pipe used in gas or oil wells, heater coils, economizers or heat exchangers, except surface coolers or exchangers, generally known as condenser box coils.

Section 4—District Heating Piping Systems. Section 4 relates to the design, manufacture, test and installation of district heating and central heating piping systems outside of buildings for the distribution of steam or hot water in excess of 15 lb. gauge. It does not apply to equipment, apparatus or pipe connections which are a part of apparatus, or to low-pressure heating piping within buildings.

Section 5—Fabrication Details. The purpose of this section is to provide a set of minimum requirement standards covering the fabrication of equipment constituting the pressure piping installations within the scope of the Pressure Piping Code and is divided into four chapters as follows: Chapter 1 deals with pipe hangers, supports, anchors, sway bracings and vibration dampeners; Chapter 2 pertains to fabrication of pipe joints, other than welded; Chapter 3 covers the preparation of parts for welding, the making and testing of welded pipe joints and the qualification of welding operators; Chapter 4 deals with approved methods of providing for thermal expansion and flexibility of piping systems.

Section 6—Material Specifications and Identification. A complete list of standard material specifications and dimensional standards, which comply with the minimum mandatory requirements of the piping systems, are included in this section of the code.

Welding Requirements. All the types of piping covered by the various sections of the Pressure Piping Code may be welded by means of several processes, as outlined in Section 5, Chapter 3, including the electric-arc, and oxyacetylene methods of fusion welding. When either of the above methods of fusion welding is used in shop fabrication or field erection of piping, it is necessary to qualify the welding operators, and the employer shall be responsible for the quality of the welding done by his organization. The tests of welders are effective for a period of six months only, where the operator has not been continuously employed on pipe-welding work. However, if the welders are regularly employed on work involving the same process and type of work, the qualifying tests may be effective for a period of one year.

The tests required by the code vary with the working pressure and temperature, as well as the fluids conveyed by the piping, depending upon whether the work can or cannot be rotated during welding. The majority of the tests are to be made on pipe of the same general quality and size as the piping to be welded, but in no case less than 6 in. nominal size. The equipment, rods and procedure used in making the test welds should be the same as employed in actual construction.

From the welded test pipes several types of specimens are cut, machined and tested, as outlined in the code. For the highest class of weld requirements, four types of test bars are necessary. The reduced-section tensile-test coupons shall have an ultimate strength not less than 90% of the minimum specified for the pipe material. The free-bend-test bars shall be bent so that the outside of the welds is on the convex surface, and the elongation of the outer fibers of the weld metal shall be at least 15%, without any perceptible cracking. The nick-break test specimens shall show complete penetration, absence of oxide and slag inclusions, and porosity not exceeding six gas pockets per square inch, with no pocket over 1/16 in. The inside-bend-test bars should be bent so that the inside of the pipe is on the convex surface, and they should not break when bent 90°.

If the qualifying tests are made under the supervision of an insurance company, it is generally necessary to develop welding specifications and procedure control for their approval, and in most cases the tests will be more rigid and extensive than those prescribed by the Pressure Piping Code, approaching those of the A. S. M. E. Unfired Pressure Vessel Code as outlined in Paragraph U-69. In addition, some insurance underwriters require that the welders make nozzle welds, from which specimens are cut, machined, polished and etched, to determine penetration, fusion and soundness of the deposited metal. This is a very desirable requisite, as many welding operators experience difficulty in making satisfactory nozzle welds.

Stress-Relieving. Welded joints in carbon steel piping shall be stress-relieved, when the wall thickness is ¾ in. or greater and service temperature in excess of 250°, by heating the structure as a unit or in sections to a temperature between 1,100° and 1,200° F. for one hour per inch of metal section, and then cooling slowly in a still atmosphere.

The code stipulates that nozzles, tees and branches ¾ in. or more in wall thickness shall be welded under shop or equivalent conditions, as stress-relieving is required. Experience indicates that piping less than ¾ in. in wall thickness requires stress-relieving, especially when made up into headers having a multiplicity of nozzles and particularly when the nozzles are reinforced. The strains set up when welding work of this character are so great that excessive warping takes place, causing serious misalignment. This has to be overcome by heating and straightening.

Piping and associated equipment fabricated with welded joints shall be capable of withstanding hydrostatic tests

as specified in the various sections for the class of service required. During hydrostatic testing, the welds shall be hammered by striking sharp vibratory blows on the material on alternate sides of the welds. The blows shall be hard enough to jar the welds without seriously denting the material.

There are no provisions in the Pressure Piping Code for the reinforcement of welded nozzles, and tests have shown that when holes are cut in a header or pipe for nozzles or branch connections the strength is reduced as much as 60%. Consequently, it is very essential that nozzle reinforcements be provided to compensate for this loss in strength. A very extensive test program is now being developed by a special sub-committee in co-operation with the Power Piping Society to determine the sizes of nozzles and pipe combinations that will require reinforcement and the types of reinforcement that are desirable. When this investigation is completed, the code will be revised to include recommended practices on nozzle reinforcement.

The Pressure Piping Code has not yet been adopted by state and municipal authorities as the legislative means of governing safety requirements for piping. Consequently, if a purchaser of equipment desires complete compliance with the code, it is necessary for him to designate the inspector who shall perform both the shop and field inspections. If insurance inspectors perform this work, the insurance company generally issues reports covering the construction, welding, and testing of the piping and copies of these reports are submitted to the purchaser, thus making it acceptable for insurance.

* * *

All the codes enumerated allow the use of welding flanges. However, the slip-on fillet-welded type of flange is limited to pressures not exceeding 300 lb. per sq. in. at 750° F. by the A. S. M. E. Boiler and Pressure Vessel Codes and the A. S. A. Pressure Piping Code. Similar limitations are also under consideration for the A. P. I.-A. S. M. E. Pressure Vessel Code.

It is evident that some misunderstanding prevails among users of the fusion-welding processes in regard to code provisions on qualification tests. While this article refers to qualified welders and the tests they must pass, it should be pointed out that the qualifying tests of welding operators are not really such, but are a part of the requirements for qualifying the employer's organization. As a matter of fact, the welding operators can weld on code work only for the employer with whom the tests were performed.

Another mistaken idea is that certificates of qualification are issued to welding operators. No insurance company engaged in shop inspection has ever made a practice of this, since the certificates would be of no value whatever to another shop, should the welder change employment, with the exception that it would indicate his competency.

The primary purpose of all the codes is to secure safe boilers, pressure vessels and piping, through minimum construction standards. It is also the intent of the codes in reference to welding to provide means that will disclose inherent defects in methods of welding and lack of competency on the part of welding operators, as defective welds are almost invariably due to lack of control of the welding procedure, or to inadequately trained welders.

The writer is indebted to C. W. Zimmer, chief inspector, and Thomas Shannon, inspector, Chicago district of the Hartford Steam Boiler Inspection & Insurance Co. for their valuable comments.

The Welder Outbids the Lathe

By ELTON STERRETT

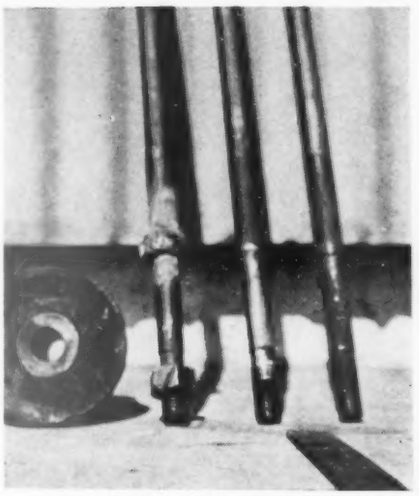
When the original rods on a 4½x5-in. duplex pump handling hot, slightly saline water under a pressure of 80 lb. per sq. in. failed through rapid corrosion in the zone subject to packing wear, it was necessary to replace the steel rods with new ones of bronze.

Continued use of the pumps, however, showed there had been merely a change of problem. Where the first rods gave way under packing wear and corrosion, the small shoulder provided by the manufacturer now yielded under the steady pounding of pumping service. A rod as furnished is shown at the right of the photograph, and one that has entirely lost its shoulder in less than a month of service, is shown next to it.

As abrading away of the shoulder permitted the piston to travel on the rod, the packing failed rapidly, and serious pump damage was averted only by frequent rod renewals. Finally, when the accumulation of replaced rods—serviceable save for loss of the necessary piston-supporting shoulder—amounted to several sets, four of the best were sent to a machine shop to be turned down until a new shoulder was formed, after which a collar was to be shrunk on, to position the piston as formerly.

Seeing one of the damaged rods, the shop welder suggested fusing on a shoulder instead of attempting to form one by the more complicated machining process specified, and was given a chance to show what could be done.

Standing a rod in the spare piston sent along to aid the machinist, and aligning it carefully as to concentricity of bore, the welder built up a shoulder of Tobin bronze on the rod which, after completion, required only the lightest facing with a file to make a water-tight fit against the piston face, and which presented sufficient area to withstand the alternate thrust and pound of pumping service.



New, Worn and Repaired Rods.
(The rod at the right is entirely new. Note the shoulder. The middle rod has its shoulder worn away. The rod at the left has a collar fused on.)

So satisfactory were the first rods so reinforced that the company using them made a practice of sending to the welder all new rods upon receipt from the factory, that they might be improved with built-up shoulders.

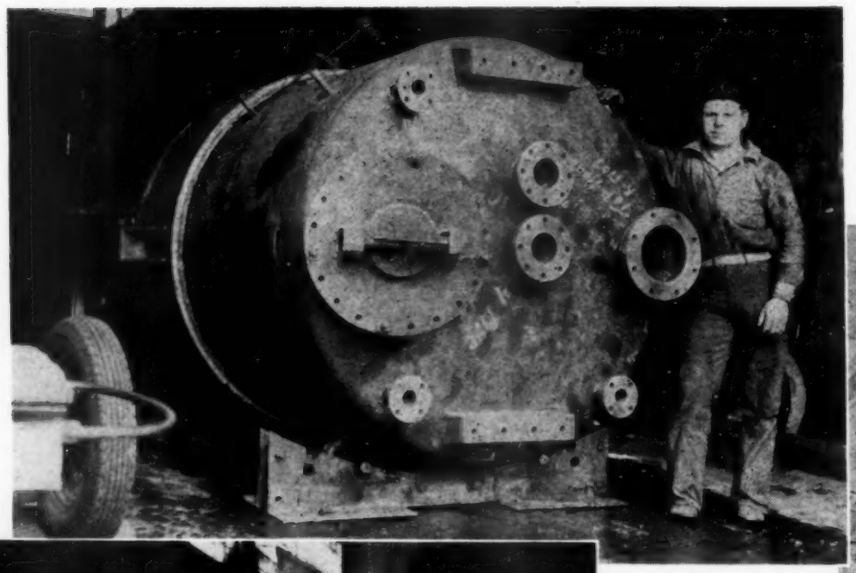
Service records show all rods so reinforced maintained practically water-tightness of fit between shoulder and piston until the rod had to be discarded from excessive packing wear on the section traversing the gland.

Provision of a shoulder adequate to maintain piston position on the rod also halved the earlier cost of packing and pump-liner replacement, owing to better control of piston travel; and the cost of the torch-built shoulder billed out at half the figure submitted for the makeshift machining substitute.

Pedals Bicycle 800 Miles to Take Welding Course

Harry L. Marsh wanted to be an electric welder, so he and his wife just bicycled up to the Westinghouse Electric & Manufacturing Co., at East Pittsburgh, Pa., from Savannah, Ga., in order to learn the trade. For 12 long days they pedaled away at the 800 miles. It was fun except for two spills and the mountains of West Virginia, according to Mrs. Marsh, who recalls: "We would climb a mountain for three hours and come down the other side in 15 minutes." The trip—eats, tourist cabins and repairs to the bikes—cost less than $40. Within a few weeks Marsh will have finished his welding training at the Westinghouse plant, and they'll be homeward bound—on their bicycles. They'll have a real story to tell their three children, who were left in Savannah.

Welding News in Pictures



• (Above) Welded jacketed steel pressure vessel built by John Nooter Boiler Works, St. Louis, Mo., measuring 5 x 6 ft.

• Welding copper expansion joints with Phos-Copper on large reservoir job at Salem, Ore.

• Twenty-ton half-section of gas-tight welded generator frame, fabricated by Westinghouse Electric & Mfg. Co.

• (Above) Electric welding in rough country on the Hope Natural Gas Company's 12-in. pipeline from Clendenin to Hastings, W. Va. Photograph by H. C. Price, Inc.

• Welders can also shoot! If you don't believe it, observe R. Dugdale, L. O. Schneiderwind, Don Carroll, Bill Mobley and R. Swanson, all of Omaha, with what they brought back from a week's trip in the Lake-of-the-Woods country.

Underwater Torch Burns At Depth of 298 Feet

A demonstration with a torch especially designed for underwater cutting was recently given by Andrew Barna, Jr., of the Calumet Welding Co., 9363 Ewing Ave., Chicago, Ill., in the course of which the torch, weighted with a 95-lb. concrete block, was lowered from a boat to the bottom of Lake Michigan, at a point 40 miles off shore, where the water was 298 ft. deep. When the torch

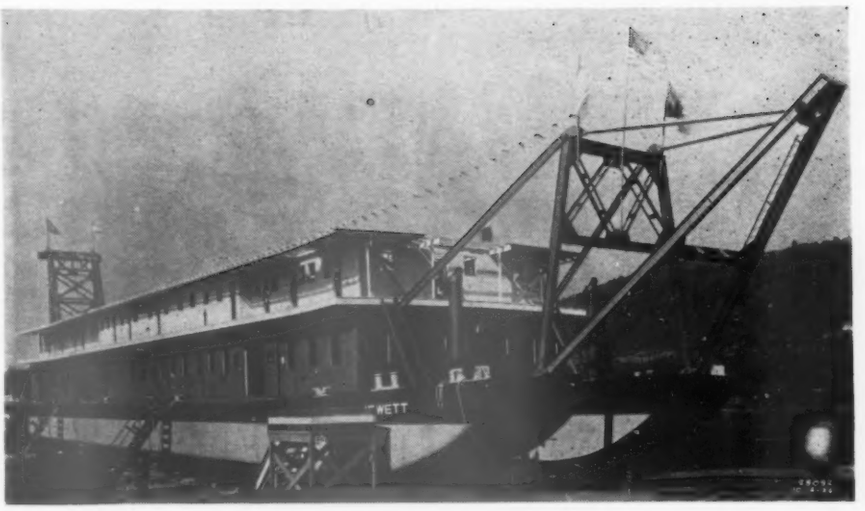
was pulled back up onto the boat, it was still burning. Oxygen at a pressure of 180 lb. and carbo-hydrogen at 180-lb. pressure were used. The purpose of the demonstration was to show the great depth at which the torch could be used without the flame being extinguished. The torch was a Victor, Model 400, redesigned by Mr. Barna for underwater cutting, and equipped with a pilot light.

Electric Welding

By CLARENCE E. FLYNN

The great electric giant
Has taken up his station
In almost every business
Conducted in creation.
He furnishes the lighting.
He keeps the home fires burning,
Does the refrigerating,
The sewing, and the churning.

He runs machines, and street cars,
And every kind of motion,
Maintains communication,
Drives ships across the ocean.
But he was not contented.
Something more he must sell me.
He's in the welding business,
And doing well, they tell me.



Welding Employed on Hydraulic Dredge

Welding had a prominent place in the construction of the U. S. Dredge *Jewett*, the largest cutter-head hydraulic dredge ever to be built on inland rivers, and a self-propelled craft, which was formally launched Oct. 14 when this giant river craft slid into the Ohio River from the marine ways of the Dravo Contracting Co., Neville Island, near Pittsburgh.

Two additional suction-type dredges of similar size are now under way on the same marine ways for the U. S. Government.

The *Jewett* has an overall length of 272 feet, a 48-foot beam, a draft of 5 ft. 6 in., and the hull is 230 ft. in length.

Many parts of this huge craft are of welded construction, including the hull and interior partitions as well as the bases and housings for the gear drums, the exhaust manifold, leading from the engine to the stack, and all-welded tanks used in the lubricating system. Welded mufflers and welded stacks were also constructed.

The dredge will be used to maintain the Ohio River channel throughout the Louisville District of the U. S. Army Engineers.

Meetings of Interest to the Welding Field . .

Chicago

Welding in maintenance work will be the subject discussed at the meeting of the Chicago section, American Welding Society, to be held in Mission Hall, Armour Institute of Technology, on Friday, Nov. 20, at 7:30 p. m. Repair welding of boilers, steam-plant equipment, and industrial equipment will be covered by Fred Lasker, of the Lasker Boiler & Engineering Corp.; Tom Jones, of the South Works, Carnegie-Illinois Steel Corp., and E. D. Benton, of the Elkhorn Coal Co. The chairman of the meeting will be L. C. Monroe, of *The Welding Engineer*. Preceding the technical session, M. K. Hudson, of the U. S. Coast Guard, will show an entertaining motion picture relating to services performed by the Coast Guard.

The Chicago Section will hold a joint meeting with the Maintenance of Way Club of Chicago on Monday evening, Dec. 14, at the Auditorium Hotel. Talks on rail-end welding and heat-treatment will be given by C. B. Bronson, inspecting engineer, New York Central Lines, New York, N. Y., and Armstrong Quinn, chief engineer, Chicago & Alton R. R., Chicago, Ill.

A reel of motion pictures entitled, "The Caveman," showing development and progress of gas welding, cutting and brazing, was shown by The Bastian-Blessing Co. at a meeting of the National Association of Practical Refrigeration Engineers, in the Engineering Building on Nov. 4. Earl Evleth and H. A. Goodwin, both of The Bastian-Blessing Co., took part in the program. Mr. Evleth gave demonstrations of pipe welding and cutting, brazing and cutting of cast iron, and soft soldering of copper tubing to brass fittings. Mr. Goodwin gave a running explanation during the demonstration. Mr. Evleth also outlined the history of welding and cutting from earliest times to the present.

A talking-movie of the Trans-Bay Bridge between San Francisco and Oakland, Calif., will be presented by Charles F. Goodrich, chief engineer, American Bridge Co., at the meeting of the Western Society of Engineers in the Engineering Building, 205 W. Wacker

Drive, at 7:30 p. m., Dec. 9. Members of the American Welding Society are invited.

Detroit

Prof. Elihu Thomson, one of America's greatest pioneers in the field of electrical science and holder of more than 800 patents, was honored on Oct. 16, when the Detroit Section of the American Welding Society dedicated its program to the fiftieth anniversary of Prof. Thomson's invention of resistance welding. The basic patent on this method of joining metals by putting them in contact with one another and then passing through them an electric current which fuses and unites the pieces, was granted in 1886. The anniversary program was presented in the Detroit Edison Co. auditorium.

Through arrangements made by Albert E. Hackett, chairman of the Detroit Section of the Society, the original welding transformer perfected by Prof. Thomson, now the property of the Franklin Institute in Philadelphia, was brought to Detroit. A. L. Rohrer, former electrical superintendent of the General Electric Co., who helped Prof. Thomson with the original experiments fifty years ago, spoke from the exact spot where the welding development work took place on the second floor of an old G-E factory building in Lynn, and his voice was carried by wire and reproduced at the meeting by a public address system.

Prof. Thomson's health is such that he was unable to make the trip from his home in Swampscott, Mass., but he sent a special message which his son, Malcolm, read to the society.

Los Angeles

"X-Ray Inspection of Welds" was the subject of a talk given by J. D. Cunningham, radiographic engineer for the Western Pipe & Steel Co., before the members of the Los Angeles Section of the American Welding Society, held on Oct. 22. Mr. Cunningham was formerly associated with The Babcock & Wilcox Co. in x-ray inspection of welded fabrication at the construction of Hoover Dam. X-ray images illustrating various faults in heavy plate welds were shown on a view box.

Milwaukee

High-speed motion pictures of flash welding, taken at the rate of 1,200 frames per second, were shown by W. E. Crawford, of the A. O. Smith Corp., at the meeting of the Milwaukee Section, American Welding Society, on Nov. 5. A number of those in attendance at the annual meeting of the Society held in Cleveland discussed the latest developments as brought out at the Cleveland meeting. The next meeting of the Section will be on Wednesday evening, Dec. 9.

Officers elected by the Milwaukee Section are as follows: Chairman, L. J. Larson, of the A. O. Smith Corp.; vice-chairman, Klaus Hansen, of the Harnischfeger Corp.; and secretary-treasurer, J. J. Chyle, of the A. O. Smith Corp. The following directors were elected for two years: Armin Kaiser, of The Linde Air Products Co.; Herbert Quartz, of the Allis-Chalmers Manufacturing Co.; and Emil Behling, of the Vilter Manufacturing Co. The membership of the section has more than doubled during the past year.

New York City

"Metallurgical Aspects of Welding Steel" was the subject of talks by E. S. Davenport and R. H. Aborn, of the research laboratory, U. S. Steel Corp., Kearney N. J., at the meeting of the New York Section, American Welding Society, on Nov. 17. The next meeting of the Section will be on Dec. 8, subject to be announced. Later meetings have been announced as follows: Jan. 11, joint meeting with A. S. M. E. on "Locomotive and Stationary Boilers"; Mar. 12, discussion of bridge welding code; Apr. 13, "Shipbuilding"; Apr. 19, joint meeting with A. S. M. on "Stresses in Welds and Their Elimination"; and May 11, the subject to be announced.

Philadelphia

"Fitting the Welding to the Job" is the subject of a paper to be given by Wm. E. Crawford, of the A. O. Smith Corp., Milwaukee, Wis., at the meeting of the Philadelphia Section, Association of Iron and Steel Engineers, to be held on Saturday, Dec. 5, at 7 p. m., at the Engineers Club, 1317 Spruce St. Members of the American Welding Society are invited to attend. The speaker will give consideration to the place welding has assumed in the fabrication of steel products. The adaptability of various methods of welding to steel products will be discussed from the standpoint of their fitness for particular jobs.

At the meeting of the Philadelphia Section, American Welding Society, held on Nov. 16, a paper on "Welding in Chemical and Refining Equipment" was given by R. K. Hopkins, director of metallurgical research for The M. W. Kellogg Co., New York, N. Y. The experience of the refining industry on corrosion in service of plain carbon steel, spray-coated steel and lined vessels was discussed by Walter Samans, chief engineer, Atlantic Refining Co.

Pittsburgh

Leon C. Bibber, welding engineer for the Carnegie-Illinois Steel Co., of Pittsburgh, Pa., was scheduled to address the Pittsburgh Section of the American Welding Society on Nov. 18 on "Methods of Showing Welding on Drawings." Mr. Bibber, Chairman of the American Welding Society sub-committee to correlate and revise symbols, was scheduled to speak on the work of his committee, recently appointed to revise all of the symbols for fusion and resistance welding with a view to avoiding the use of conflicting symbols.

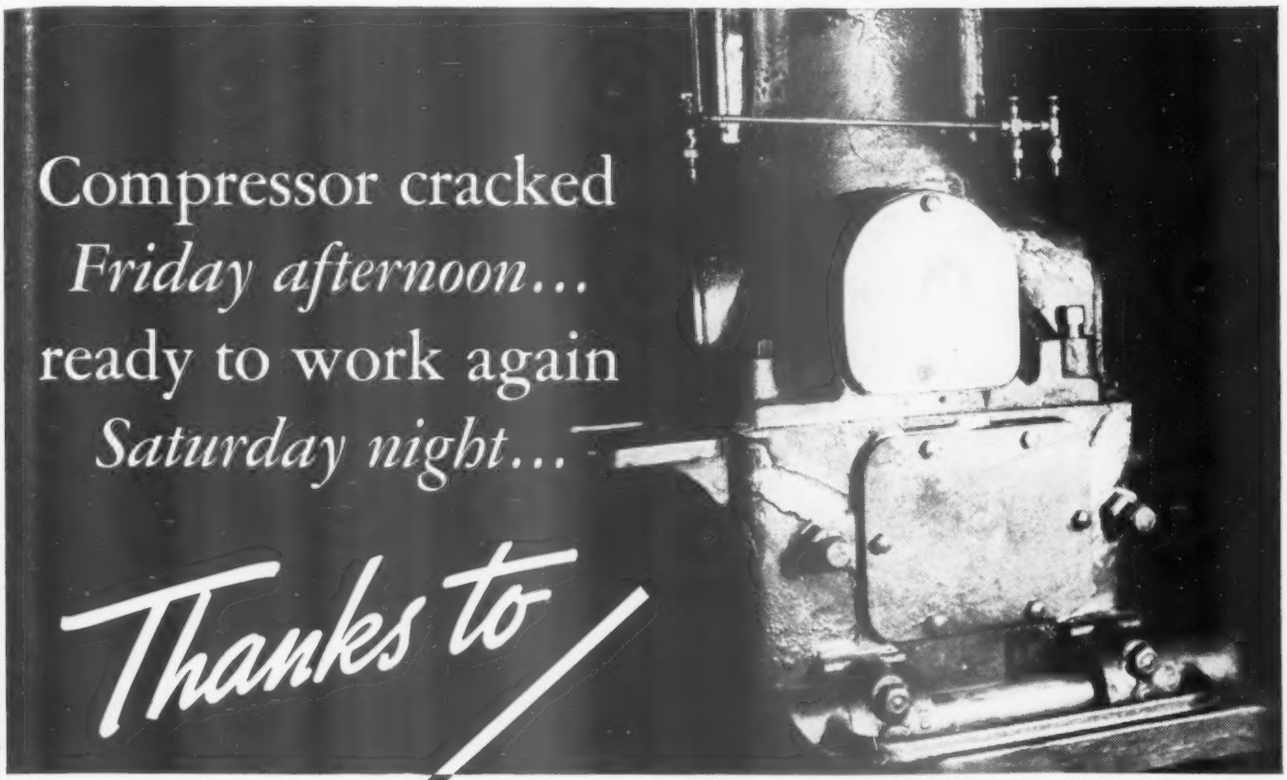
On Nov. 5, C. F. Goodrich, chief engineer, American Bridge Co., Pittsburgh, Pa., addressed the Civil Engineering Section of the Engineering Society of Western Pennsylvania on "The San Francisco-Oakland Bay Bridge" and gave a complete story of its erection, illustrated by slides and a sound-motion-picture film. That same evening, Porter H. Brace of the Westinghouse Electric & Manufacturing Co., East Pittsburgh, addressed the Science of Metals Club in the Bureau of Mines Auditorium, Pittsburgh, on "Recent Alloy Developments."

The American Society of Safety Engineers were joint sponsors with the Western Pennsylvania Safety Council for the 15th annual safety conference and exhibit held in the ballroom of the William Penn Hotel, November 12-13 and attended by some 3000 safety delegates from the Tri-State District. A large number of exhibitors participated and welding safety devices were displayed by the Pulmosan Safety Equipment Corp., Brooklyn, N. Y., Willson Products, Inc., Reading Pa., and the Mine Safety Appliances Co., Pittsburgh.

The widening use of welded steel and lightweight alloys in buildings, bridges and other large metal structures occupied a prominent place on the program of the fall meeting of the Pittsburgh, Cleveland and Central Ohio Sections of the American Society of Civil Engineers, which was held in Pittsburgh, Oct. 13-16, at the Hotel William Penn. Upwards of 300 engineers attended. Features of the meeting were a symposium on structural application and lightweight alloys at the Wednesday and Thursday morning sessions. At the Wednesday afternoon session, the metallurgical aspects of ferrous and lightweight alloys of interest in structural design and fabrication were discussed.

San Francisco

At the meeting of the San Francisco Section of the American Welding Society, held on Oct. 30, Gordon L. Von Plank, chief metallurgist for the Columbia Steel Co., gave a talk on "Low-Alloy High-Tensile Steel," dealing with its manufacture and use. K. V. King followed Mr. Von Plank with his interesting and informative review of outstanding current articles pertaining to welding and cutting, including a short abstract of the subjects covered in the October issue of the *American Welding Society Journal*.



The air compressor after being repair-welded with Tobin Bronze

Tobin Bronze Welding!

HERE is another striking instance in which Tobin Bronze welding saved time and money for a plant owner.

Shortly before closing on a Friday afternoon ...in a New England foundry...an air compressor head cracked in several places. The entire plant was put out of commission. But . . . a welding company made the repair on Saturday, *using Tobin Bronze.* Saturday night the machine was as good as new. Thanks to Tobin Bronze *. . . the compressor was out of service for one day only.*

Because of the size and shape of the casting, preheating in a furnace would have been impossible and the loss of time involved in waiting for a new casting would have caused serious expense. Further . . . in several places the crack extended through bolt holes, making it necessary to insert threaded carbon rods where the repair was made and melt Everdur Metal around them. It is doubtful if any method other than Tobin Bronze welding could have saved the time and expense of a new casting.

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from mine to consumer

* * *

Time and again Tobin Bronze has proved itself the most satisfactory welding rod for difficult jobs on cast and malleable iron by making satisfactory repairs at low cost. Tobin Bronze carries the trade-mark "Tobin Bronze Reg. U. S. Pat. Off." in each rod. Look for this trade-mark and make certain that you are getting *genuine* Tobin Bronze.

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Anaconda Welding Rods

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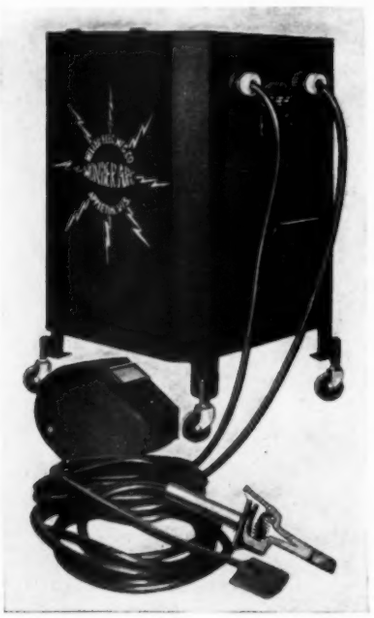
Offices and Agencies in Principal Cities . . . In Canada: ANACONDA AMERICAN BRASS LTD., New Toronto, Ontario

What's New in Equipment and Supplies

Transformer-Type Welders Rated Up to 600 Amperes

A new a. c. portable welder is announced by the Miller Electric Manufacturing Co., Appleton, Wisc., under the trade name "Wonder Arc". It is of the transformer type, and is said to have a high power factor. It provides reactance control and a static high-frequency arc. A sheet metal attachment makes possible the welding of thin metals. In capacity, the new welders range from 125 to 600 amperes, standard voltage 220, 60 cycles, single phase.

Since these units are not of the auto-transformer type, there are no electrical connections between the power input and the welding leads, and they can be used to weld on grounded systems, such as for thawing frozen water pipes. The exact amperage is supplied by a rotating



"Wonder Arc" Transformer Welder.

knife-switch control with the amperage distinctly marked indicating each welding step.

These new models supplement the existing line of a. c. welders manufactured by the Miller Electric Manufacturing Co.

New Welding Electrode for 4-6%-Chrome Steels

Steels known as 4-6%-chromium steels, which are rapidly gaining acceptance in applications requiring resistance to crude-oil corrosion at high temperatures and pressures, can be successfully welded by use of "Chromeweld 4-6," it is claimed by The Lincoln Electric Co., Cleveland, O., who have just announced the new electrode.

The 4-6%-chromium steels possess a resistance to sulphide corrosion four to ten times that of ordinary steel and a resistance to oxidation at 1,000° F. three times as great. The new electrode contains molybdenum and provides weld metal possessing the necessary high creep strength and other qualities essential for welding these steels. Such steels after welding, can be soft annealed to physical properties similar to those of mild carbon steel, and therefore rendered suitable for equipment where severe cold-working is applied during fabrication.

"Chromeweld 4-6" deposits, produced with proper welding procedure and fully annealed at 1,550° to 1,600° F., followed by slow cooling in the annealing furnace, on air cooled from 1,200° are said to possess approximately the following characteristics: Tensile strength, 65,000 to 70,000 lb. per sq. in.; yield point, 35,000 to 40,000 lb. per sq. in.; ductility, 35% to 40% elongation in 2 in.; reduction in area, 65% to 75%; and hardness (Brinell), 130 to 140.

If stress-relieved at 1,400° F., the physical properties of the deposit are approximately as follows: Tensile strength, 80,000 to 90,000 lb. per sq. in.; yield point, 55,000 to 65,000 lb. per sq. in.; ductility, 24% to 30% elongation in 2 in.; reduction in area, 60% to 70%; and hardness (Brinell), 155 to 175.

Applications include furnace tubing, cracking stills, hot-oil transfer lines, heat exchangers, bubble-tower caps, return bends, valves, superheater headers and other similar applications.

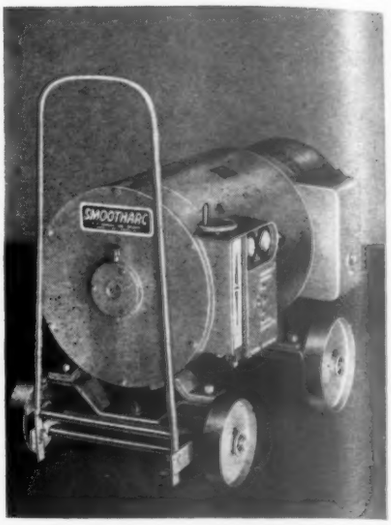
"Chromeweld 4-6" is a coated electrode and is made in three sizes—⅛, 5/32 and 3/16 in.

Simplified Line of "Smootharc" Welders

A new line of "Smootharc" welders, featuring simplification in outward appearance and in operation with single current control, self-excitation and internal stabilization, has been announced by the Harnischfeger Corp., 4513 W. National Ave., Milwaukee, Wis.

These welders are built in both vertical and horizontal types, for stationary or portable mounting. The vertical units, compactly and uniformly designed, come in three sizes—75, 100 and 150 amperes. The horizontal units, in 200, 300, 400 and 600 ampere capacities, are streamlined to minimize projecting parts, and present a neat, compact appearance, all of which assure easy portability.

All sizes of these welders are provided with single current control, made possible by a special design of shifting generator brushes. Through the medium of a micrometer screw device, the brush shifting gives an infinite number of current settings. Open-circuit voltage is maintained at a desirable high value at all current settings. The voltage regulation is automatic and requires but a turn of the handwheel control to adjust the welding current.



Neat, Compact Welding Unit.

Self-excitation is accomplished through a set of auxiliary brushes placed ahead of the main brushes and connected to an auxiliary shunt winding. These auxiliary brushes operate in a magnetic field independent of the main field. The auxiliary brushes attached to the main brush ring are shifted simultaneously with the main brushes, thus regulating the proper amount of excitation made available at each current setting.

Internal stabilization is obtained through the use of an interpole winding extended to the main pole shoes. Speedy arc recovery is secured through the combination of short-circuit winding and a magnetic bridge located in the main field magnetic circuit.

In this new line of welders, the streamlined appearance is accomplished through the use of all-rolled-steel and arc welded construction. All steel parts, field ring, pole shoe, etc., are annealed to give the highest possible quality magnetic field for generator fluxes.

A. C. Welders of Light Weight and Simple Design

A supplement to their line of standard a. c. welders being sold under the trade name "Giant Grip", has been announced by the Giant Grip Manufacturing Co., Oshkosh, Wis. This new line of welders, known as "Giant Grip Junior," are lighter in weight than the standard welders due to the wood construction of the cabinets and the arrangement of the amperage control, there being only ten controls in two of the models and 16

On the skilful checking of the minutest details hangs life and death . . . **Protect against Tuberculosis by CHECKING YOUR HEALTH**

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controls in the other two, while the standard welders have 27 and 36 controls.

Like the standard models, these new welders are of the transformer type but without reactance control, static high-frequency arc or sheet-metal attachment. They have the same insulation thickness and the same temperature rise as the standard models, and are as safe and easy to operate. Each is equipped with rotating knife-switch control with amperage distinctly marked indicating each step in welding.

Trade Literature

"Enduro" stainless and heat-resisting steels are described in five new pamphlets issued by the Republic Steel Corp., Cleveland, O. One booklet is general, illustrating many uses of these steels, and including a table of corrosion data. Another pamphlet deals with the 18-8 types of steels, while another treats of types HCN, HC and NC-3, all oxidation-resistance steels. A fourth booklet describes 4-6%-chromium steels. Types AA, FC, S and S-1 chromium steels are discussed in a fifth publication. These pamphlets deal with physical properties, forming, welding, brazing, soldering, heat-treatment, cold working, etc.

Alloys for resistance-welding dies and electrodes are described in three illustrated folders issued by P. R. Mallory & Co., Indianapolis, Ind. One of these folders deals with "Elkonite," and illustrates its application as die and electrode material. Another cites illustrations of high outputs obtained with "Elkaloy" in seam and spot welders; and the third folder describes uses of "Mallory 3" metal, and illustrates one tip that made 900,000 spot welds before replacement was necessary.

Dual continuous control, and how it is obtained in the new "Shield Arc S. A. E." welders, is explained in simple words and diagrams in a new pamphlet issued by The Lincoln Electric Co., Cleveland, O. Features of construction and operation — 32 in all — also are described, together with many illustrations.

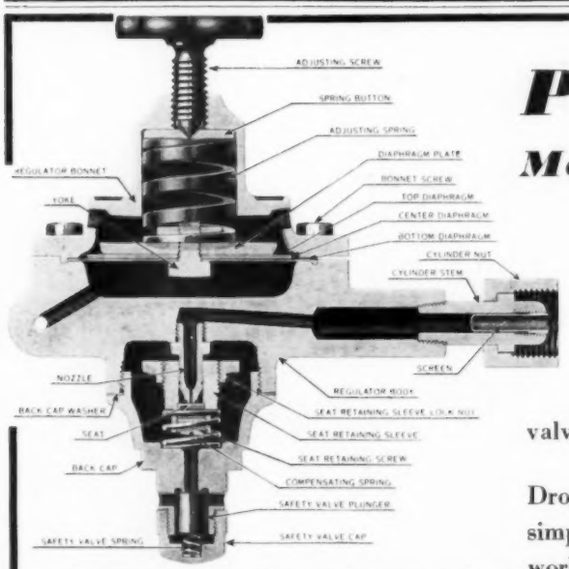
"Baldwin-Southwark" is the name of a new house organ to be published quarterly by the Baldwin-Southwark Corp., Paschall P. O., Philadelphia, Pa. The first issue, which has just made its appearance, observes the 100th anniversary of the company by giving considerable historical information, with illustrations.

The new line of "Smoothare" welders developed by the Harnischfeger Corp., 4513 W. National Ave., Milwaukee, Wis., is described in Bulletin W-8, just released by this company, which deals with single control, self-stabilization, self-excitation and other features of these machines.

Acetylene and oxygen connections are listed along with their many other products, including air-line lubricators, regulating and reducing valves, automatic gas regulators, relief valves, strainers, etc., in Catalog 200, published by the C. A. Norgren Co., Inc., Denver, Colo.

A new bulletin on "Manganal" manganese-steel welding electrodes and applicator bars, illustrating numerous applications, has been issued by the Stulz-Sickles Co., 91 N. J. Railroad Ave., Newark, N. J.

The new "Smoothare" automatic welding head, using standard coated



Perfect Gas Control

Means Economy and Efficiency

Every welder knows that perfect control of gases spell economy in oxygen and acetylene, that it affects the quality of his welds and his working speed.

So old hands prefer a TORCHWELD REGULATOR. It enables them to do better work, and the automatic release-valve insures safety, cuts repair costs and gives long life.

Drop forged parts, triple metal diaphragms crimped in position, simplicity of design and expert workmanship all combine to give TORCHWELD REGULATORS their pre-eminence.

Manifolds Economize

When you have several tanks on a job, cut gas wastage with a TORCHWELD MANIFOLD. (Shown at right). Made to order for from 2 to 20 tanks, for both oxygen and acetylene. Write for prices.

Send for Torchweld Regulator and Manifold Prices.

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rods, is described in Bulletin W-9, issued by the Harnischfeger Corp., 4513 W. National Ave., Milwaukee, Wis.

A new price list on Sil-Fos, Easy-Flo and Handy Flux, issued by Handy & Harman, 82 Fulton St., New York, N. Y., lists several new standard sizes in brazing alloys, in addition to the usual sizes. Easy-Flo is now listed in strip form as well as wire form.

"Thawing Frozen Water Pipes" is the title of a timely booklet issued by the Hobart Brothers Co., Box FW-116, Troy, Ohio, which gives the essential information on actual cases of pipe thawing.

Research metallographic equipment, for visual and photographic work, combined in one unit, is described in Catalog E-240, which was recently issued by the Bausch & Lomb Optical Co., Rochester, N. Y.

"The Making and Shaping of Alloy Constructional Steels" is the title of Bulletin F-1, published by The International Nickel Co., Inc., 67 Wall St., New York, N. Y.

Equipment for low-power photomicrography is described in Catalog F-19, issued by the Bausch & Lomb Optical Co., Rochester, N. Y.

F. D. Wood is conducting the business of Brad Snodgrass Inc., 2514 Bethel Ave., Indianapolis, Ind., since the recent death of Mr. Snodgrass.

F. R. Faulk, distributor for Ever-Klear cover lenses, has removed from 50 Penn Avenue, Pittsburgh, Pa., to 405 Penn Avenue.

The Houston Oxygen Co. is building a modern compressed-acetylene plant in Houston, Tex.

Commercial News

An exhibit featuring condenser tubes and also showing copper and copper-alloy welding rods, and products of copper, Tobin bronze, Everdur and Tempaloy, will comprise the display of The American Brass Co. to be shown in space No. 65 at the National Exposition of Power & Mechanical Engineering, Grand Central Palace, New York City, on Nov. 30 to Dec. 5.

Frank M. Farmer, past president of the American Welding Society and of the American Society for Testing Materials, has been elected chairman of the Engineering Foundation, which is the research organization of the national engineering societies. Mr. Farmer is vice-president and chief engineer of the Electrical Testing Laboratories, New York, N. Y.

Comfort A. Adams, consulting engineer and formerly emeritus professor of engineering, Harvard University, is now consulting engineer for the Edward G. Budd Manufacturing Co., Philadelphia, Pa. Mr. Adams is a past president of the American Welding Society and for many years has been active in Society activities and on code committees.

E. T. Slackford has been appointed advertising manager of the Harnischfeger Corp., Milwaukee, Wis., succeeding Wood Sanford. Mr. Slackford has spent more than ten years in industrial engineering and sales-promotion work, both with manufacturers and advertising agencies.

Manufacturers' literature is desired for the library of the Welders Association. All material should be addressed to George A. Combridge, Welders Association Library, 1179 Market St., San Francisco, Calif., where it will be made available to the membership.

Frederick Salditt, export manager of the Harnischfeger Corp., Milwaukee, Wis., has been elected vice-president of the concern. Mr. Salditt, who joined the Harnischfeger Corp. 13 years ago, will continue to retain supervision of foreign operations.

R. L. Scollard, who was with the Gulf States Steel Co., of Birmingham, Ala., until they recently discontinued their line of welding electrodes, is now connected in a sales capacity with the Big Three Welding Equipment Co., of Houston, Tex.

The Welding of Aluminum made Easy with

Walco Aluminum Rod

TYPE E-1—for the Arc
TYPE G-2—for Gas

Have you had any difficulty with your welding of aluminum? Here's a special rod that will prove itself. It's being used by thousands of welders for good, clean results. Soft ductile, the rods give weld tensiles of 22,000 p. s. i. with either the torch or arc. *Packed for easy use, one pound net in mailing tube.*

Try Walco E-1 or G-2 yourself. Send for a sample and the name of your nearest distributor.

WELDING ALLOYS MFG. CO.
110 Washington St.
New York, N. Y.

OUR EXHIBIT at the Metal Show, Cleveland, Oct. 19-23 (shown above) illustrating the origination and development of the hand gas lighter from 1901 to present day by Safety Gas Lighter Company, acquainted thousands with the 35 years' research, experimentation and pioneering that has produced the Improved "Round File" lighter of today.

The Improved "Round File," incorporating the many superior design and construction features conceived and developed over this 35-year period, has proved itself truly the Welder's Favorite. Try it and determine why, to your own satisfaction. Order trial lighter today. **Descriptive circulars and prices on request.**

ORIGINATORS OF THE HAND GAS LIGHTERS **SAFETY GAS LIGHTER CO.** Est. 1901 **LYNN, MASS.**

Notes From the Field

The American Barge Line has placed a contract with the Dravo Contracting Co., of Pittsburgh, Pa., for a fleet of 12 barges to be used in the company's increasing freight trade between Pittsburgh and southern ports. These carriers will be of the all-welded type, 175 ft. long, 26 ft. wide and 11 ft. deep. Approximately 1,800 tons of steel plates and shapes will be required. Under construction in the same shipyards at the present time, is a fleet of 10 all-welded steel coal barges, of standard size, for the Pittsburgh Coke & Iron Co. These barges are 175 ft. long, 26 ft. wide and 10.8 ft. deep, and will have a capacity of 1,000 tons each.

Arc and gas welding operators are in great demand in the Pittsburgh industrial area, and several of the large fabricators, particularly among the boat yards, have been advertising for arc welders capable of doing first-class work. In this connection, the Pittsburgh School of Trades, 405 Penn Ave., announces it has placed 56 graduates in paying jobs during the past sixty days. With the steel industry moving along at a fast rate, and with the barge and boat companies busier than at any time since 1929, the outlook for those engaged in welding is unusually reassuring.

Rapid progress is being made at the Dravo Contracting Co. shipyards, Neville Island, Pittsburgh, Pa., on the conversion of six steel barges into the largest wharfboat on the Ohio River for the Green Line Steamers at Cincinnati, O. The completed boat will be 348 ft. long, 76 ft. wide and 7.6 ft. deep and will have an all-welded superstructure. Work is now under way in putting the finishing touches to the steel house on the deck, which will be 354 ft. long, 70 ft. wide and 16 ft. high. Delivery is expected to be made in December.

A contract for the construction of a steam stern-wheel towboat, for service on the lower Mississippi River, has been awarded by the Standard Oil Co. of New Jersey to the Marietta Manufacturing Co., of Point Pleasant, W. Va. It will be of the all-welded type, with steel hull and boiler deck, while the cabin will be of wood construction. The hull will be 190 ft long, 42 ft. wide and 7.6 ft. deep. The boat will be the highest-pressure steam vessel on inland rivers. Delivery is promised for early spring of 1937.

The towboat *Opon* is being built at the plant of the Marietta Manufacturing Co., Point Pleasant, W. Va., for the International Petroleum Company, of Toronto, Ontario, Canada. This boat, which is for service on South American rivers, is of the steam stern-wheel type, 173 ft. long, 44 ft. wide, and 5.6 ft. deep, and will be equipped with tandem compound engines, according to Senator Charles O. Weissenburger, president of the Marietta company.

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Ryerson Engineers have developed a series of rods that are outstanding for Quality production. More than twenty types including both electric and gas rods are carried in stock. Whether you need a shielded arc type for production work or a stainless steel rod you can be sure of immediate shipment.

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Ryerson Green Processed No. 18
Ryerson Green Processed No. 6
Ryerson Bare Mild Steel
Ryerson Brown Processed
Ryerson White Flux Coated
Ryerson High Carbon White Flux Coated
Ryerson Blue Flux Coated
Ryerson 3½% Nickel Steel Flux Coated
Ryerson High Manganese Steel
Ryerson Hard Surfacing
Ryerson Allegheny Stainless Flux Coated
Ryerson Allegheny Stainless No. 44

GAS RODS

Ryerson Copper Coated No. 206
Ryerson Copper Coated No. 210
Ryerson Cast Iron
Ryerson 3½% Nickel Steel
Ryerson Tobin Bronze
Ryerson High Carbon Bare No. 2110
Ryerson Allegheny Stainless Bare
Ryerson Hard Filler

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Buffalo. Boston. Philadelphia. Jersey City

The Fluor Corp. of Los Angeles, Calif., contractor for the Panhandle Eastern Pipeline Co. on their booster stations at Dumas, Tex., and Liberal, Greensburg, Haven and Olpe, Kan., have practically completed their contract. With few exceptions all pipe was fabricated by either arc or oxy-acetylene welding on these booster stations.

The School of Welding, at 7421 S. Alameda Blvd., Los Angeles, Calif., reports 30 students enrolled in its different classes. The institution, owned and managed by "Tom, the Welder," recently underwent an extensive expansion program following a marked increase in business. Eight new welding units, all 200-ampere size, were added.

Rods used to form the entire steel frame of the new edifice of St. Augustin's Catholic Church in Culver City, Calif., were joined together by wrapping and then welding, according to reports. The entire frame was fabricated at the plant of State Steel Products, Inc., Los Angeles, and then moved to the building site in panel sections.

Albert Burk, 50, former Pittsburgher, is sought by the Missing Persons Bureau. He was a welder in factories in the Pittsburgh area, weighs about 160 lb. and is approximately 5 ft. 6 in. Anyone knowing of his whereabouts should communicate with the Missing Persons Bureau, Pittsburgh, Pa.

The Frank Wiggins Trade School, Los Angeles, Calif., opened the fall term with an enrollment of 47 welding students in the day classes. All courses and training are under the direction of J. W. McCartney, veteran instructor, who has been with the institution for many years.

E. J. Shuler, 513 East 61st St., Chicago, Ill., announces the establishing of a welding school to give advanced courses in the welding of stainless steel, aluminum, monel and other metals, with attention given to theoretical, practical and metallurgical training.

Recently the Kansas City Structural Steel Co., Kansas City, Mo., placed an immense girder weighing 102 tons in the new Wyandotte High School Building, under construction in Kansas City, Kan. Some welding was involved.

The Northern Natural Gas Co., of Omaha, Nebr., are rushing to completion their new booster station at Bushton, Kan. Welding is playing an important part in the construction of this plant.

R. E. Fillmore, who operates the Augusta Welding & Machine Shop,

(Trade Mark Registered)

Welds made with

PENN*

doubly deoxidized

Bronze Welding Rods

*U. S. Patent Number 2,022,439

possess

Greater Strength

combined with

Greater Ductility

due to the exclusive Double Deoxidation feature, found only in Titan alloys.

dditional features of Penn Bronze and her Titan Welding Alloys that cause em to be preferred by welders everywhere include:

Uniform Tinning
Low Melting
Low Fuming
Corrosion Resistance

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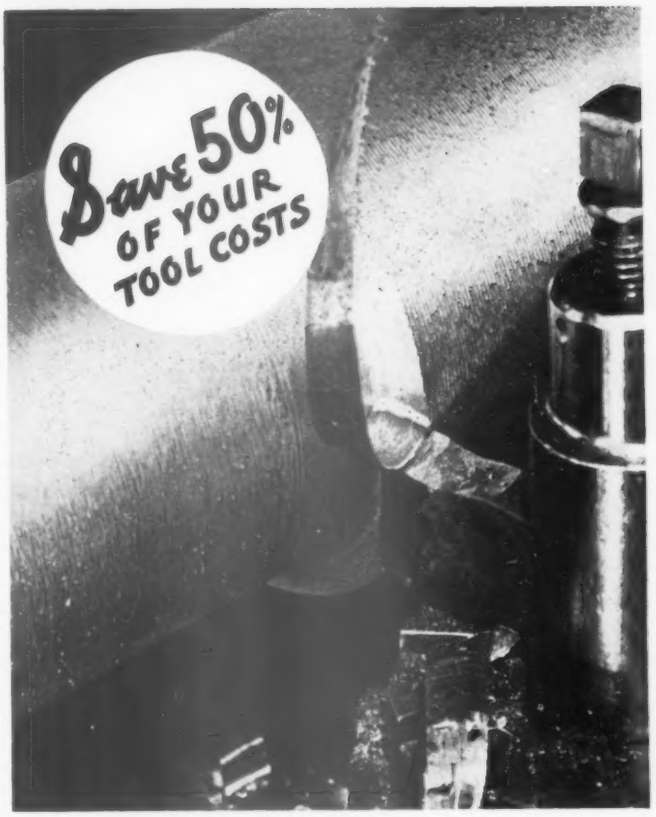

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A fraction of an ounce of Stoodite "54" or Stoodite "63", applied to an inexpensive S.A.E. 1045 blank, produces a high quality cutting tool for use in shapers, lathes and boring mills.

Stoodite "63" is extremely hard and should be applied to tools used in cutting hard materials, such as chilled cast iron and heat treated alloy steels.

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STOODY COMPANY
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The welding of three rows of 36-in. water pipe at the plant of the Cincinnati Water Works, California, Ohio, is being done by the Union Welding and Boiler Works, 4224 Spring Grove Ave., Cincinnati.

Continuous rail-end welding by the thermit-pressure method was recently employed on the tracks in the train shed at the Milwaukee, Wis., station of the Chicago, Milwaukee, St. Paul & Pacific Railroad.

M. A. Buchanan of Buck's Welding Works, Long Beach, Calif., is building a new portable electric unit for his field jobs in the Signal Hill oil field. A new 300-ampere generator will furnish the current.

A job recently done by The Superior Welding Co., Peoria, Ill., was the replacement of two all-welded steel buckets on a "Ready Mix Cement" mixer for McElwee and Rogy Inc., of Peoria.

The Cleveland School of Welding, Cleveland, O., continues to add new equipment for the training of their students, the latest addition being six new light-production welding torches.

S. Hasterdlo, proprietor of the Stanley Fender and Body Co., of Omaha, Nebr., reports a recent substantial increase in the number of large gasoline tanks on passenger busses he has been called on to weld.

The Superior Welding Co, 331 Knoxville, Peoria, Ill. have just completed building a soda-pop truck and remodeling several others.

The Metals Maintenance Corp., conducting a welding school, has moved to 11125 Vincennes Ave., Chicago, Ill. The former address was 9207 S. Western Ave.

Guy's Auto Clinic, 4328 Leavenworth St., Omaha, Nebr., are welding steel frames and bodies for automobiles and house trailers.

· CLASSIFIED ADS ·

Help Wanted—75c per line, minimum 4 lines. Jobs Wanted—4 lines free. Other Ads—$1.00 per line, minimum 4 lines Count 8 words to line. Add 6 words for keyed address.

FOR SALE

LIQUIDATION EXCESS STOCK BARGAINS

3-in-1 Metallizer spray gun, $150.00; Metalspray ⅛-in.-wire gun, $175.00; 300-amp. gas-engine Lincoln welder; 400-amp. gas-engine Hansen welder; 4,000 ft. rubber-covered super-flexible cable. Address N-2, The Welding Engineer.

Fly Ball Governors—Adapted to all makes of auto engines; belt driven, flat or V. Price, $6.50 prepaid. Ball bearing, $2.00 additional. Satisfaction guaranteed. In ordering state style of belt. Wm. Alber, Beatrice, Nebr.

Bargains—Demonstrator Arc Welders. Gasoline and electric drive. 30 days' trial. Easy terms if desired. Write Ken's Exchange, Box U-1161, Troy, Ohio.

BUSINESSES FOR SALE

Welding and Boiler Shop For Sale—Well equipped. Doing good business year around. Suitably located in good farming, fruit, resort and lumber country. Reason for selling: ill health. C. W. Dean, Ft. Myers, Florida.

Welding Shop For Sale—Doing good business. In fast growing oil town. Portable equipment. $800.00 will handle. L. E. Brickel, Pampa, Texas.

MISCELLANEOUS

Arc Welders—Build Your Own, saving $300 to $500. Complete instructions furnished. Easy pays-its-own-way terms. Investigate before you buy any welder. Hobart Welder Sales, Box U-462, Troy, Ohio.

POSITIONS WANTED

Welding Engineer—Civil engineering and sales background. Experienced in design, detailing, estimating, research, shop and field supervision on structural work, hand and automatic welding. Responsible charge in shop, office and field. Available on reasonable notice. Age 35. Address N-1, The Welding Engineer.

Combination Welder—3 years' experience, including repair and production welding with the arc and repair welding with gas. White, 23, and single. Will work anywhere. Ford Rhoades, Box 437, West Unity, Ohio.

Welder—7 year's experience in electric and gas welding; 2 years in production, 5 years in job shop. Honest and reliable. Single; willing to go anywhere. Address N-3, The Welding Engineer.

Welder and Blacksmith—Steady employment wanted; 17 years' experience at electric and acetylene welding. Prefer job shop or place with contractor. Wm. H. Levin, Box 44, Lena, Ill.

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The "all position" electrodes for use on mild and medium carbon steels.

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